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ABSTRACT

This workbook is designed to meet the energy planning needs of colleges and universities in organizing, developing, and implementing an energy management program based on individual campus needs. The workbook is organized into three sections which address diagnosis, program development, and implementation. By using the exercises provided, campus administrators can integrate "hard" data with "soft" local data about the campus history and organization lead to effective planning. The workbook provides worksheets for all aspects of energy use and related facilities. These worksheets are targeted at the different members of the administrative team including the president, the business officer, and facilities director. The worksheets collect data regarding both current practices and desired future outcomes. These are accompanied by narratives that explain how to complete the worksheets and how to use the resulting data for planning. A glossary of terms is included. (Contains 110 references.) (JLS)

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# THE ENERGY MANAGEMENT WORKBOOK

REVISED EDITION

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APPA
The Association of Higher Education
Facilities Officers

# THE ENERGY MANAGEMENT WORKBOOK

REVISED EDITION

Revisions by
Chris Crittenden

**Disclaimer**
The concepts and guidelines presented in this publication are intended to assist facilities managers in the efficient and effective management of their energy programs. These are guidelines only and are not industry standards. Opinions expressed in this book are those of the authors and do not necessarily reflect the opinions of APPA. Mention of companies and products are for informational purposes only and are not intended by the publisher as an endorsement of any kind.

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# Preface

This revised edition of the *Energy Management Workbook* was prepared to continue to meet the needs of those institutions that want to eliminate energy waste on campus and reduce unit costs, but lack the resources (capital, human, technical) to implement the energy conservation projects that would increase their efficiency or address unit costs. This workbook provides updated information on energy assessment, management practices, and financing mechanisms to enable higher education facilities to increase the energy efficiency and reduce energy costs of their campus.

The original workbook was funded by a grant from the Exxon Education Foundation, and was originally developed by the Higher Education Energy Task Force, representing the American Council on Education (ACE), the National Association of College and University Business Officers (NACUBO), and APPA: The Association of Higher Education Facilities Officers. These organizations combined their energy efforts to identify and articulate higher education's energy needs, to plan strategies to meet these needs, and to serve as a national resource of energy data.

Initially, the impact of rising fuel costs and the uncertain availability of fuel forced educational institutions to redirect limited operational and programmatic resources to energy expenditures. In the early 1970s, the typical small college spent approximately 20 percent of its annual operation and maintenance budget to cover energy costs, compared to more than 55 percent in the 1980s. Today, the proportion of energy costs to operation and maintenance budget is changed only by the institution's level of commitment to activities addressing both unit consumption and costs.

## Acknowledgments

First and foremost, APPA wishes to acknowledge Chris Crittenden, president of Cardinal Concepts, for his many contributions to this publication. As the former director of APPA's Higher Education Energy Task Force, Chris helped secure the original funding from the Exxon Education Foundation, to whom we remain grateful.

Chris prepared the original workbook in the mid-1980s with the assistance of Josh Burns, John MacLean, and Sy Zachar. We greatly appreciate the time he has spent to review and revise the publication for a mid-1990s audience. John MacLean deserves special recognition for reviewing financial issues for this edition.

APPA thanks the following individuals who reviewed the manuscript and provided valuable advice and assistance: Dorsey D. Jacobs, West Virginia University; Charles W. Jenkins, Saint Mary's University; Mohammad H. Qayoumi, San Jose State University; and Roger E. Rowe, Miami University. Others who offered helpful comments include: Robert H. Fuller, Robert H. Fuller & Associates, Inc.; F.G. Hutson, Queen's University; Stewart McLaughlin, P.E.; and Michael A. Stevenson, Columbus State Community College.

The page and chart design for this book was accomplished on APPA's desktop publishing system by Medea M. Ranck, who also copyedited the manuscript and handled all production matters. Steve Glazner and Wayne E. Leroy provided assistance in the development of this revised edition. APPA also thanks Wayne Hilburn, Hilburn Communications, and Ed Scott, Harlowe Typography, for their help at the production stage.

# ■ Introduction

This workbook is designed to meet the energy planning needs of colleges and universities to organize, develop, and implement an energy management program. The original workbook was organized around five basic premises. Still appropriate today, the first is suggested by the title of a Carnegie Commission on Higher Education report published in the early 1980s called "Three Thousand Futures." The commission recognized that each institution of higher education is unique because of its facilities, location, faculty, resources, personnel, and history. No single planning or management approach can be suggested that would fit any two campuses exactly in the same way.

The second premise is that the only plan that a college will undertake to implement is one in which the key administrators have had a part in developing. Within this premise is an acknowledgment of the fact that, on a campus, decisions are made by relatively few individuals, usually on an informal basis, but continuously. Actions are based on a consensus by these key personnel.

The third operating premise is that no one understands or knows the campus better than campus personnel. While outside expertise, such as engineers and architects, is valuable, the institution itself is the best resource for developing solutions to problems, energy or others.

The fourth premise is that energy management is a subset of facilities management. The two cannot be separated. A physical plant that is poorly maintained will never be energy efficient. The technological fix such as a central control system only masks the true reduction potential. A well-maintained campus also produces dividends that extend beyond energy savings—enhanced life of the facilities and equipment, a "pride" of campus, and a valuable asset for student recruitment.

Finally, this workbook assumes that resources to reduce energy consumption are available through a combination of internal and external funding sources. Internally, energy may be viewed as a recurring liability. Proper external financing will allow the campus to restructure its debt, creating a positive cash flow that will release funds to support the campus mission of teaching.

An energy management strategy must fit the college in three ways. It must meet the physical requirements of the campus, the people that will carry out the plan, and match the resources (equipment, personnel, capital). To address the greatest opportunities for improving energy use on most campuses, this workbook focuses on building energy use; transportation operations, as well as industrial energy processes, are not considered.

The design of the workbook will help you to develop a plan for your campus based on its own needs. This can be done by using the planning process, which is organized into three basic steps: Diagnosis, Program Development, and Implementation. Each preceding section builds to the next, so it is important to answer all questions and collect all data before moving to the next section. Time estimates are provided to assist you in planning your time to complete the exercises.

All data requested is to be reported by calendar year. If you choose an academic or fiscal year, make sure that it remains consistent throughout the analysis.

## Using the Workbook

This workbook is organized into three basic sections: Diagnosis, Program Development, and Implementation. By integrating the "hard" data developed by these exercises with the "soft" information about campus history and organization, campus administrators can develop an understanding of where the campus is and how it got there. Only by acknowledging "what is" can the college develop a plan for the future.

## Section I: Diagnosis

This section is divided into three chapters: Energy and Facility Management Perspectives, Facilities, and Financing. Put another way, these chapters could be called people, facilities, and money.

Before discussing the worksheets, it is important to step back a minute to discuss the backdrop against which energy management occurs on campus.

### Energy and Facility Management Perspectives

The development and implementation of an energy reduction plan requires more than information or a thickly bound report with numbers and graphs. These too often simply serve as expensive dust collectors or nicely bound volumes for storage on the shelf.

Energy management requires first and foremost an organizational consensus or agreement to move ahead to develop a plan that all key administrators and operating personnel "buy into" and are therefore willing to carry out. Only when that occurs is information deemed valuable and used.

Essential to this commitment is the president. Unless the president supports good facility management, effective energy reduction will not occur. As early as 1727, presidential responsibility for the campus was recognized. The statutes of the College of William and Mary state, "Concerning the President—Besides learning, and skillful in business, and industrious and diligent in the management of all affairs. . . . He must provide, in due time, that the edifices be duly kept up and repaired." That responsibility still exists.

The chief financial officer must know that the president cares about and expects good facility and energy management, or it will not occur. At many small colleges the vice president for business is the keystone in the energy management effort.

This officer allocates the resources for the facilities department, as well as for all nonacademic, and, on some campuses, academic functions as well. The facilities department and its director often report to the business officer. The administrative directive and resources to reduce consumption come from this office.

Campus resources are subject to fierce competition and are allocated according to your support base. The facilities department often lacks a strong support base. In a job that is often invisible to the academic community, the facilities director is on the firing line. With the resources allocated, the manager must provide the physical and environmental support that enables the college to carry out its mission.

The president, business officer, and facilities director each has a very different perspective on facilities, energy, and resources. This means that different things are being said and heard, although each is using the same words and terms.

The Energy and Facility Management Perspective Worksheets are designed to help these adminstrators examine their current views toward energy and facilities, what their role in the energy management process is, and what responsibility each has and exerts. Therefore, the worksheets will only be valuable to you if you are honest in your answers. There are no right or wrong answers, no judgment implied. Rather, the forms are designed as a form of organizational and energy "self."

It is only when administrators are clear as to their purpose, perspectives, and priorities that they can be discussed intelligently, and a consensus developed. Section II: Program Development contains worksheets to guide and facilitate the development of an energy management consensus.

## Facilities

Information provides the building blocks from which a facility and energy management program is built. The five exercises in this chapter of Section I are treated as a single sequence of activities (see flow chart on page 33). The exercises provide information necessary for two purposes. First, they provide the campus with the information necessary to develop a program. Second, they also provide a common set of numbers to be used by the president, business officer, and facilities director in developing a consensus of "what needs to be done." Each of the five exercises includes a set of instructions and a completed sample.

## Financing

Because no planning can be done without resources, Section I concludes with a detailed discussion of the principles of energy financing and the barriers (often self-imposed) to financing necessary improvements. This chapter asks the college to change its thinking about how it budgets energy and views its liabilities.

# Section II: Program Development

The development of the campus's energy program draws on the information and experience recorded and organized in Section I.

## Developing an Energy Management Consensus

This chapter contains two principle "consensus guides": one for the president and business officer, and a second one for the business officer and facilities director. These guides are a framework for discussion.

The worksheets are designed to focus on areas of agreement. What are the key points on which individuals agree? Only after concluding principle areas of agreement are you asked to focus on areas where disagreement occurs. The worksheets ask why, and attempt to focus the cause of the disagreement. Once discussed, you may find more agreement than disagreement. The facility information developed in Section I, coupled with the issues raised in the financing section, should provide all the participants with the same view or perspectives of the campus's facilities, the need to reduce energy consumption, and the areas that will require attention.

It is strongly suggested that this chapter be completed in an off-campus location that is comfortable and conducive to good conversation and interchange, uninterrupted by phone calls and other intrusions. The meeting should be scheduled so that there is no time pressure.

The concluding questions of this chapter direct the president, business officer, and facilities director to commit to take the actions that each has agreed to and that each feels will move the campus energy efforts forward.

Depending on the campus situation it may be desirable, but not necessary, for the facilities director to have conducted the brainstorming session (see worksheet for facilities director and operating staff) with the personnel prior to the meeting with the business officer, and for the director to have completed the Scheduling Energy Management Activities Worksheet (Exercise 6).

The implementation of an energy management program will rest largely on the operating staff of the facilities department. American management has recently made two "discoveries." It is a well-known fact that 1) if you want to develop solutions, those closest to the problem often have the answers, and 2) involvement in the decision-making process creates in those who carry out the tasks a commonality of purpose and task that translates into quality work. Each of these practices are a part of the current thinking of quality management approaches.

To facilitate this, a worksheet and instructions on brainstorming are included in this chapter (pages 73-76).

The last section of this chapter (see Energy Manager and Building Users, page 75) recognizes that collegiate organizations are not hierarchical per se. Considerable political weight or "clout" is carried by the faculty, and their consensus is also required. Therefore, instructions are included to provide a context within which the faculty can provide input into the energy management process. By involving the faculty, consensus is enhanced. Not involving them only creates obstacles that must then be overcome.

## Facilities

The next step in developing a program is to pull together the facility management information developed. Two worksheets are provided. The first is a simple listing, on a per building basis, of the activities for the facility, based on the information developed in the consensus process above. The second worksheet builds from the facilities portion of Section I. Both of these worksheets are utilized in Developing the Energy Management Plan, the last set of worksheets in Section III.

While many of the actions and activities will require little in the way of additional resources, capital expenditures may be required for some.

## Financing Evaluation of Energy Investments

This chapter will enable the business officer to evaluate the benefits, costs, and options available to the campus to finance capital projects. Because capital projects, if properly financed, can enhance or increase the cash flow of the institution (i.e., the savings in energy dollars is greater than the cost of implementing and financing the measure), this chapter should be carefully reviewed and the energy financing self-assessment questions completed, page 83.

## The Energy Management Plan

This chapter contains a series of forms that consolidate and finalize all the information developed in this workbook up to this point. When these forms are completed serially, the campus's energy management plan will emerge on the last sheet.

# Section III: Implementation

The implementation plan is basically a sequence of actions, determined and organized by administrators, that establish for each action its priority, when the action can be implemented, who is responsible for it, the ten-year cash flow improvement the activity will generate, the implementation cost (if any), the financial source (if one is required), and, finally, any academic, faculty, or management implications.

This last worksheet simply puts the plan in a form that can be communicated campuswide and used to track the progress to date. Like any plan, it is not set in stone. Rather it is a working document or road map. During the course of its energy "journey" the college may choose to change directions or go faster or slower, and these should be noted on the plan. It is recommended that the plan be reviewed and revised annually by the president, business officer, and facilities director, and then presented to the board of trustees. Ultimately, the trustees have the fiduciary responsibility for the campus, and energy is a part of that responsibility.

## Is This Workbook Worth Your Time?

Now that you have read the introduction, you will probably thumb through the book and question whether or not the time it takes you to complete this workbook is really worth it. Appropriate question!

To help you determine if it is worth your time, take a few minutes to calculate the cost/benefit of completing the workbook. You should compare the cost of personnel time required to complete the workbook with the expected energy you will save.

Estimate the total salaries of the president, business officer, and facilities director.

$ ________________________

Divide that by the number of work days at your institution:

$ ________________________ = Daily cost.

We estimate the total time required to complete the workbook to be five people days: three for data and information collection and two for facilities personnel involvement.

What is the total current energy budget for the campus? $ ________________

Now take the energy bill for your campus and multiply it by .05 (5%).

$ ______________________

**What is the cost ratio of completing this energy workbook?**

Daily cost of president, business officer, and facilities director is

$ ______________________ (1).

This cost (1) times 3 days = $ ______________________ (2).

Hourly cost of facilities personnel is $ ______________________ (3).

This cost (3) times 16 hours = $ ______________________ (4).

Total costs (2) + (4) for the five days is $ ______________________ (5).

Energy budget for the current year is $ ______________________ (6).

Five percent of your energy budget is $ ______________________ (7).

The ratio of (5) to (7) is ______________________ .

We feel that at a minimum you can save 5 percent of your energy budget by going through this process.

# Section I: Diagnosis

CHAPTER 1

# ■ Energy and Facility Management Perspectives

## The President's Worksheet

Estimated completion time: 10 minutes.

NOTE: The number in parenthesis is the number of the corresponding question on the business officer's worksheet ( page 13.)

### Current Energy Related Activities

1. Do you currently have an energy management plan or reduction target? That is, do you have an organized or systematized list of activities and actions to reduce energy use with an accompanying schedule to implement them? (1)

☐ Yes ☐ No

2. If yes, was the plan developed with input from various members of the campus community, and does it include: facility modifications, utilization or schedule changes, and operating changes? (2)

☐ Yes ☐ No

3. If no, is energy consumption being reduced annually (adjusted for weather and square footage), but without a formal plan? (3)

☐ Yes ☐ No

4. If consumption is not being steadily reduced and there is no plan, is it because (5):

a. ☐ energy interest has peaked
b. ☐ the college does not pay any attention to it
c. ☐ it is not seen as an area where savings are still attainable
d. ☐ the college has done about all it can do given the resources available

e. ☐ there are higher priorities such as recruitment and student retention
f. ☐ other

5. If your campus has an energy plan, was it developed or approved by you and/or your board? (6)

☐ Yes ☐ No

6. Is the importance of energy reduction communicated (discussion in staff meetings, memos, policy statement, part of orientation materials, communicated in the dorms by the RAs ) to the campus? (7)

☐ Yes ☐ No

7. Do you monitor campus energy consumption? (10)

☐ Yes ☐ No

## Who Makes Energy Decisions on the Campus?

8. List the energy related responsibilities or activities of your job, for example, budgeting or resource allocation, personnnel, space, facilities, etc. (17)

1.________________________________________
2.________________________________________
3.________________________________________
4.________________________________________
5.________________________________________

9. List, in order of importance, the people you depend on, or whose cooperation you need to conduct the energy responsibilities of the college (e.g., business officer, facilities director, registrar). (18)

| Name | How often | Involvement |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

10. Rank yourself, the business officer, and the facilities director as to the priority you feel each gives energy management; i.e., what priority do you feel energy is given based on time commitment, verbal or written action or directive, or results to date? (19)

| | Top | High | Medium | Low |
|---|---|---|---|---|
| Self | ☐ | ☐ | ☐ | ☐ |
| Business Officer | ☐ | ☐ | ☐ | ☐ |

| | Top | High | Medium | Low |
|---|---|---|---|---|
| Facilities director | ☐ | ☐ | ☐ | ☐ |

## Facilities Maintenance and Energy

The following questions are based on the premise that energy management is a subset of facilities management. Put another way, energy cannot be managed or consumption reduced if the campus's facilities and energy systems are not maintained properly.

11. Based on actions or results, is the campus's physical plant viewed as an asset or a liability? That is, as one of, if not the largest college asset, is its value being maintained or enhanced, or is it being allowed to slowly deteriorate? Its value is being: (20)

☐ enhanced ☐ maintained ☐ reduced

12. If its value is not being enhanced or maintained, what would be required to do so? (21) Check all that apply.

☐ recognition of the current value and condition by administration
☐ capital funds for renovation and repairs
☐ additional funding for operation and maintenance
☐ additional personnel, particularly ____________________
☐ additional skills in the staff, including
____________________________________________
☐ different personnel (i.e., replacements)
☐ more cooperation from ____________________

13. A. What is the replacement value of the physical plant? (22A)
$ ____________________________________________

B. If you do not know, estimate by using this formula:

Number of square feet for all campus buildings x $70.00 =
$ ____________ replacement value

C. Are you spending between 1 and 1.5 percent of its replacement value on maintenance? (22C)

☐ Yes ☐ No ☐ Don't know

D. If you do not know, use the following formula to find out:

Replacement value $ ________ x .01 = $ ________

This amount $ ________ – current maintenance expediture
$ ________ = a maintenance deficit of $ ________ .

E. Does this maintenance deficit surprise you?

☐ Yes ☐ No

14. How often do you personally review the condition of the campus buildings, their maintenance, general condition, work being performed on campus (capital projects), or delivery of service by campus vendors such as custodial contractors? (26)

☐ Rarely ☐ Periodically ☐ Monthly ☐ Weekly ☐ Daily

Worksheets and a suggested plant tour of the campus energy systems are on pages 25-30.

15. Do you feel you have adequate facility, financial, and energy management information with which to make decisions? (31)

16. Based on the above questions, what do you consider to be the five major impediments to energy management campus wide? (32)

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

17. Based on the above, in order of priority, what do you consider to be the five most important steps, actions, needs, or requirements necessary to reduce consumption? (33)

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

# The Business Officer's Worksheet

Estimated completion time: 30 minutes.

NOTE: The number in parenthesis is the number of the corresponding question on the president's worksheet (page 9).

## Current Energy Related Activities

1. Do you currently have an energy management plan or reduction target? That is, do you have an organized or systematized list of activities and actions to reduce energy use with an accompanying schedule to implement them? (1)

☐ Yes ☐ No

2. If yes, was the plan developed with input from various members of the campus community, and does it include: facility modifications, utilization or schedule changes, and operating changes? (2)

☐ Yes ☐ No

3. If no, is energy consumption being reduced annually (adjusted for weather and square footage), but without a formal plan?(3)

☐ Yes ☐ No

4. If possible, list the percentage reduction achieved for each of past six years:

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

5. If consumption is not being steadily reduced and there is no plan, is it because: (4)

a. ☐ energy interest has peaked
b. ☐ the college does not pay any attention to it
c. ☐ it is not seen as an area where savings are still attainable
d. ☐ the college has done about all it can do given the resources available
e. ☐ there are higher priorities such as recruitment and student retention
f. ☐ other

6. If your campus has an energy plan, was it developed or approved by you and/or your board? (5)

☐ Yes ☐ No

7. Is the importance of energy reduction communicated (discussions in staff meetings, memos, policy statement, part of orientation materials, communicated in the dorms by the RAs) to the campus? (6)

☐ Yes ☐ No

8. If yes, list the more common methods by which it is communicated.

1. ________________________________
2. ________________________________
3. ________________________________
4. ________________________________
5. ________________________________

9. Regardless of whether energy reduction is being achieved through a formal plan, or simply actions taken, list what you consider to be the most important steps taken to date by the campus and, if possible, the savings in consumption each step achieved. For example, institution of preventive maintenance, lighting reduction, computer control systems, calendar changes, utilization or scheduling changes, double glazing, new systems, increased attention to energy systems.

| Actions | Savings |
|---|---|
| | |
| | |
| | |
| | |
| | |

10. Do you monitor campus energy consumption?

☐ Yes ☐ No

11. If you do monitor your consumption, what method do you use?

a. ☐ utility and/or fuel bills
b. ☐ computerized energy management systems
c. ☐ meter readings
d. ☐ other

12. How often do you review consumption?

a. ☐ monthly
b. ☐ quarterly
c. ☐ by semester or semi-annually
d. ☐ annually
e. ☐ periodically, but on no set schedule

13. In monitoring consumption, do you track it in relation to previous consumption patterns, i.e., last year's consumption for the same period?

☐ Yes ☐ No

14. If you do not monitor consumption, is that because (check all that apply)

a. ☐ there are other, more pressing concerns
b. ☐ that is someone else's responsibility
c. ☐ it is not really possible to monitor consumption because ______________
d. ☐ I do not see the bills
e. ☐ other

## Who Makes Energy Decisions on the Campus?

15. List the five major responsibilities or activities of your job.

1. ____________________________________________
2. ____________________________________________
3. ____________________________________________
4. ____________________________________________
5. ____________________________________________

16. Is responsibility for energy one of those top five?

☐ Yes ☐ No

If yes, what number of importance did you give it? __________

17. List the energy related responsibilities or activities of your job, for example: budgeting or resource allocation, personnel, space, facilities, etc. (8)

1. ____________________________________________
2. ____________________________________________
3. ____________________________________________
4. ____________________________________________
5. ____________________________________________

18. List, in order of importance, the people you depend on or whose cooperation you need to conduct the energy responsibilities of the college (e.g., stationary engineer, facilities director, registrar, dorm director). Then for each, cite how often (once a week, month, semester), and in what manner you involve each in the decisions you make that affect energy and the campus. Do you meet with them, send memos or letters, or otherwise solicit their advice, ideas, and support in carrying out energy related responsibilities? (9)

| Name | How often | Involvement |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |
| 4. | | |
| 5. | | |

19. Rank yourself, the president, and the facilities director as to the priority you feel each gives energy management; i.e., what priority do you feel energy is given based on time commitment, verbal or written action or directive, or results to date? (10)

| | Top | High | Medium | Low |
|---|---|---|---|---|
| Self | ☐ | ☐ | ☐ | ☐ |
| President | ☐ | ☐ | ☐ | ☐ |
| Facilities director | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ |

## Facilities Maintenance and Energy

The following questions are based on the premise that energy management is a subset of facilities management. Put another way, energy cannot be managed or consumption reduced if the campus's facilities and energy systems are not maintained properly.

20. Based on actions or results, is the campus's physical plant viewed as an asset or a liability? That is, as one of, if not the largest college asset, is its value being maintained or enhanced, or is it being allowed to slowly deteriorate? Its value is being: (11)

☐ enhanced ☐ maintained ☐ reduced

21. If its value is not being enhanced or maintained, what would be required to do so? (12) Check all that apply.

☐ recognition of the current value and condition by administration
☐ capital funds for renovation and repairs
☐ additional funding for operation and maintenance
☐ additional personnel, particularly ______________________________
☐ additional skills among the staff, including ______________________
☐ different personnel (i.e., replacements)
☐ more cooperation from ____________________________________

22. A. What is the replacement value of the physical plant? $____________ (13A)

B. If you do not know, estimate by using this formula: (13B)

Number of square feet for all campus buildings __________ x $70.00 =
$ _______________ replacement value.

C. Are you spending between 1 and 1.5 percent of its replacement value on maintenance? (13C)

☐ Yes ☐ No ☐ Don't know

D. If you do not know, use the following formula:

Replacement value $ ____________ x .01 = $ _______________ .

This amount $ _________________ – current maintenance expenditure
$ _______________ = a maintenance deficit of $ _______________ .

E. Does this maintenance deficit surprise you?

☐ Yes ☐ No

23. Could additional skills or training provide the campus with greater output from existing funding or staffing?

☐ Yes ☐ No

24. What types of training or skill development would be required?

a. ☐ boiler maintenance
b. ☐ electrical repair
c. ☐ motor repair
d. ☐ steam trap maintenance
e. ☐ high power voltage
f. ☐ cooling equipment maintenance
g. ☐ other technical skills or trades
h. ☐ supervisory
i. ☐ leadership
j. ☐ communications
k. ☐ managing the problem worker
l. ☐ other

25. Are training courses that cover the deficiencies cited above available in the local community?

☐ Yes ☐ No

If they are, can you send employees to such training programs if you are not already doing so?

☐ Yes ☐ No

26. How often do you personally review the condition of the campus buildings, their maintenance, general condition, work being performed on campus (capital projects), or delivery of service by campus vendors such as custodial contractors? (14)

☐ Rarely ☐ Periodically ☐ Monthly ☐ Weekly ☐ Daily

27. Is the amount of time you spend "out on campus" adequate; that is, do you feel you have a good sense of what is going on out there?

☐ Yes ☐ No

28. At least once a month, do you and the facilities director take a walking tour of the campus?

☐ Yes ☐ No

29. How complete is the tour? Does it cover: (Circle the items *not* covered on the tour.)

roofs cooling towers hallways offices
labs and classrooms basements and boiler rooms central heating plants
grounds roads special problems and projects

Worksheets and a suggested plant tour of the campus energy systems are on pages 25-30.

30. At the end of the tour, are decisions or plans made to address the problems highlighted by the tour?

☐ Yes ☐ No

Are these decisions reviewed on subsequent tours?
☐ Yes ☐ No ☐ Sometimes

31. Do you feel you have adequate facility, financial, and energy management information with which to make decisions? (15)

☐ Yes ☐ No

32. Based on the above questions, what do you consider to be the five major impediments to energy management campus wide? (16)

1. ________________________________________
2. ________________________________________
3. ________________________________________
4. ________________________________________
5. ________________________________________

33. Based on the above, in order of priority, what do you consider to be the five most important steps, actions, needs, or requirements necessary to reduce consumption? (17)

1. ________________________________________
2. ________________________________________
3. ________________________________________
4. ________________________________________
5. ________________________________________

# The Facilities Director's Worksheet

Estimated completion time: 30 minutes

NOTE: The facilities director's worksheet is identically numbered to correspond to the business officer's worksheet (pages 13-18).

## Current Energy Related Activities

1. Do you currently have an energy management plan or reduction target? That is, do you have an organized or systematized list of activities and actions to reduce energy use with an accompanying schedule to implement them? (1)

☐ Yes ☐ No

2. If yes, was the plan developed with input from various members of the campus community, and does it include: facility modifications, utilization or schedule changes, and operating changes? (2)

☐ Yes ☐ No

3. If no, is energy consumption being reduced annually (adjusted for weather and square footage), but without a formal plan? (3)

☐ Yes ☐ No

4. If possible, list the percentage reduction achieved for each of the past six years:

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

5. If consumption is not being steadily reduced and there is no plan, is it because: (4)

   a. ☐ energy interest has peaked
   b. ☐ the college does not pay any attention to it
   c. ☐ it is not seen as an area where savings are still attainable
   d. ☐ the college has done about all it can do given the resources available
   e. ☐ there are higher priorities such as recruitment and student retention
   f. ☐ other

6. If your campus has an energy plan, was it developed or approved by you and/or your board? (5)

☐ Yes ☐ No

7. Is the importance of energy reduction communicated (discussions in staff meetings, memos, policy statement, part of orientation materials, communicated in the dorms by the RAs) to the campus? (6)

☐ Yes ☐ No

8. If yes, list the more common methods by which it is communicated.

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

9. Regardless of whether energy reduction is being achieved through a formal plan, or simply actions taken, list what you consider to be most important steps taken to date by the campus and, if possible, the savings in consumption each step achieved. For example, institution of preventive maintenance, lighting reduction, computer control systems, calendar changes, utilization or scheduling changes, double glazing, new systems, increased attention to energy systems.

| **Actions** | **Savings** |
|---|---|
| | |
| | |
| | |
| | |
| | |

10. Do you monitor campus energy consumption?

☐ Yes ☐ No

11. If you do monitor your consumption, what method do you use?

a. ☐ utility and/or fuel bills
b. ☐ computerized energy management systems
c. ☐ meter readings
d. ☐ other

12. How often do you review consumption?

a. ☐ monthly
b. ☐ quarterly
c. ☐ by semester or semi-annually
d. ☐ annually
e. ☐ periodically, but not on a set schedule

13. In monitoring consumption, do you track it in relation to previous consumption patterns, i.e., last year's consumption for the same period?

☐ Yes ☐ No

14. If you do not monitor consumption, is that because (check all that apply)

- a. ☐ there are other, more pressing concerns
- b. ☐ that is someone else's responsibility
- c. ☐ it is not really possible to monitor consumption because ______________
- d. ☐ I do not see the bills
- e. ☐ other ______________________________________________

## Who Makes Energy Decisions on the Campus?

15. List the five major responsibilities or activities of your job.

1. ______________________________________________
2. ______________________________________________
3. ______________________________________________
4. ______________________________________________
5. ______________________________________________

16. Is responsibility for energy one of those top five?

☐ Yes ☐ No

If yes, what number of importance did you give it? ______________

17. List the major energy related responsibilities or activities of your job, for example: budgeting or resource allocation, personnel, space, facilities, etc. (8)

1. ______________________________________________
2. ______________________________________________
3. ______________________________________________
4. ______________________________________________
5. ______________________________________________

18. List, in order of importance, the people you depend on, or whose cooperation you need to conduct the energy responsibilities of the college (e.g., stationary engineer, business officer, registrar, dorm director). Then for each, cite how often (once a week, month, semester), and in what manner you involve each in the decisions you make that affect energy and the campus. Do you meet with them, send memos or letters, or otherwise solicit their advice, ideas, and support in carrying out energy related responsibilities?(9)

| Name | How often | Involvement |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |
| 4. | | |
| 5. | | |

19. Rank yourself, the president, and the business officer as to the priority you feel each gives energy management; i.e., what priority do you feel energy is given based on time commitment, verbal or written action or directive, or results to date? (10)

| | Top | High | Medium | Low |
|---|---|---|---|---|
| Self | ☐ | ☐ | ☐ | ☐ |
| President | ☐ | ☐ | ☐ | ☐ |
| Business officer | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ |

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☐ enhanced ☐ maintained ☐ reduced

21. If its value is not being enhanced or maintained, what would be required to do so? (12) Check all that apply.

☐ recognition of the current value and condition by administration
☐ capital funds for renovation and repairs
☐ additional funding for operation and maintenances
☐ additional personnel, particularly ________________ ________________
☐ additional skills among the staff, including ________________________
☐ different personnel (i.e., replacements)
☐ more cooperation from ______________________________

22. A. What is the replacement value of the physical plant? $ ________________

B. If you do not know, estimate by using this formula: (13B)

Number of square feet for all campus buildings ____________ x $70.00 =
$ ______________________________ replacement value.

C. Are you spending between 1 and 1.5 percent of its replacement value on maintenance? (13C)

☐ Yes ☐ No ☐ Don't know

D. If you do not know, use the following formula:

Replacement value $ __________________ x .01 = $ ________________.

This amount $ ____________________ – current maintenance expenditure
$ ____________________ = a maintenance deficit of $ ____________________.

E. Does this maintenance deficit surprise you?

☐ Yes ☐ No

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☐ Yes ☐ No

24. What types of training or skills development would be required?

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h. ☐ supervisory
i. ☐ leadership
j. ☐ communications
k. ☐ managing the problem worker
l. ☐ other

25. Are training courses that cover the deficiencies cited above available in the local community?

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28. At least once a month, do you and the business officer take a walking tour of the campus?

☐ Yes ☐ No

29. How complete is the tour? Does it cover: (Circle the items *not* covered on tour.)

roofs
cooling towers
hallways
offices
labs and classrooms
basements and boiler rooms
central heating plants
grounds
roads
special problems and projects?

Worksheets and a suggested plant tour of the campus energy systems are on pages 25-30.

30. At the end of the tour, are decisions or plans made to address the problems highlighted by the tour?

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Are these decisions reviewed on subsequent tours?

☐ Yes ☐ No ☐ Sometimes

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☐ Yes ☐ No

32. Based on the above questions, what do you consider to be the five major impediments to energy management campus wide? (16)

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

33. Based on the above, in order of priority, what do you consider to be the five most important steps, actions, needs, or requirements necessary to reduce consumption? (17)

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

# Tour of the Campus Facilities and Energy Systems

Executive (and board) understanding of energy is often built solely on dollars and energy units. Numbers on a memorandum do not necessarily provide a clear understanding of where energy dollars go and what the problems are. To provide a common perspective and understanding, it is suggested that the facilities director and business officer take the president, and perhaps board members, on a tour of the campus facilities and energy systems.

This tour is designed to encourage mutual understanding so that solutions can be developed. The basic thrust should be on current conditions. But it must also be recognized that very often campus energy bills are paid by reducing, through attrition or otherwise, plant staff. Fewer personnel means that fewer things get done. Such tasks as painting the exterior windows, repairing the roof, and steam plant or boiler maintenance are performed less frequently. Before beginning the tour, the facilities director may wish to conduct a brief presentation on the historical aspects of the campus energy use, past reduction efforts, and the impact of rising energy costs, particularly on the facilities department itself. The following two charts will set the stage for the tours.

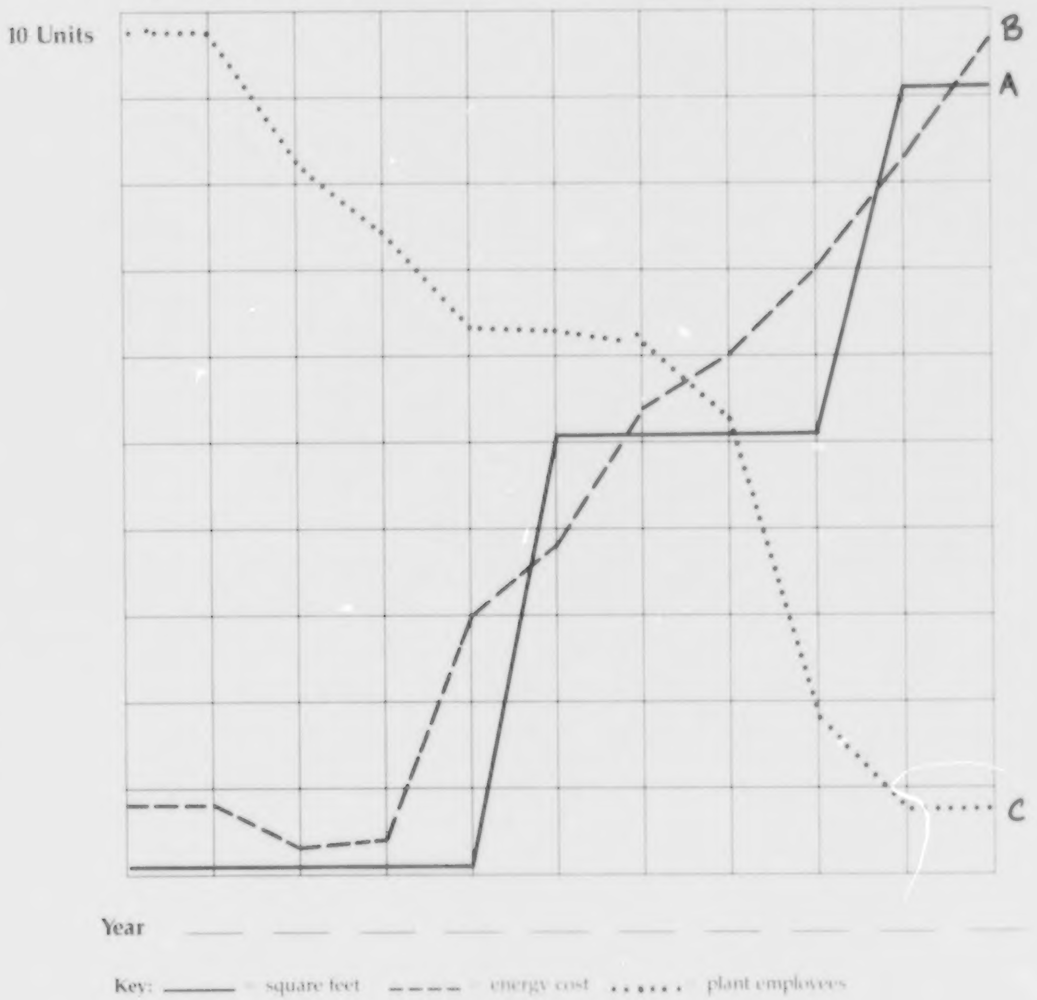
## Chart 1: Facilities Department History

For each year below, insert the campus square footage, total annual campus energy costs, and the number of employees in the facilities department. (A "typical" scenario is one of increasing square footage, increasing energy costs, and decreasing personnel.)

| Year | Square feet (A) | Energy $ (B) | Plant empl. (C) |
|---|---|---|---|
| 1984 | 1.0 | 1.47 | 50 |
| 1985 | 1.0 | 1.45 | 46 |
| 1986 | 1.0 | 1.46 | 44 |
| 1987 | 1.0 | 1.60 | 42 |
| 1988 | 1.1 | 1.64 | 42 |
| 1989 | 1.1 | 1.70 | 41 |
| 1990 | 1.1 | 1.75 | 40 |
| 1991 | 1.1 | 1.80 | 30 |
| 1992 | 1.2 | 1.87 | 29 |
| 1993 | 1.2 | 1.93 | 29 |
| | | | |

## Chart 1: Example

To graph you need:
A. gross square footage B. total energy bill C. total plant employees



## Chart 2: Energy Costs History

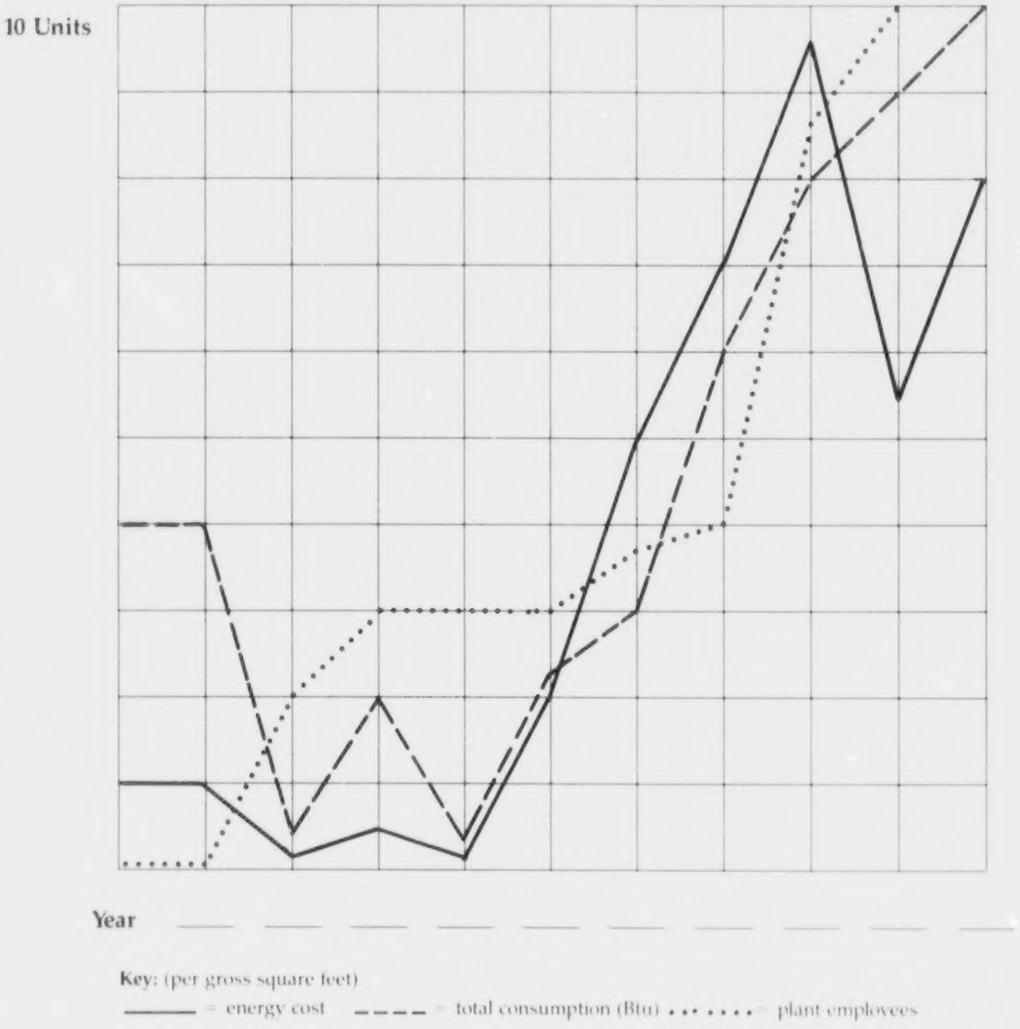
For each of the same years used in Chart 1, show the energy costs per square foot, energy use per square foot, and the number of employees per square foot. This should further illustrate how personnel costs were constrained in order to cover the utility bills.

| Year | Energy $/square foot (A) | Btus/square foot (B) | Plant empl./square foot (C) |
|---|---|---|---|
| 1984 | 1.47 | 125,000 | 20,000 |
| 1985 | 1.45 | 121,000 | 23,000 |
| 1986 | 1.46 | 123,000 | 26,000 |
| 1987 | 1.45 | 121,000 | 26,000 |
| 1988 | 1.49 | 123,000 | 26,000 |
| 1989 | 1.55 | 124,000 | 27,000 |
| 1990 | 1.59 | 127,000 | 28,000 |
| 1991 | 1.64 | 129,000 | 37,000 |
| 1992 | 1.56 | 130,000 | 41,000 |
| 1993 | 1.61 | 131,000 | 41,000 |
| | | | |

## Chart 2: Example

To calculate you need:

1. energy cost per square foot = Total energy bill ÷ gross square feet ______
2. energy use per square foot = Total consumption (Btu) ÷ gross square feet ______
3. employees per square foot = Total plant employees ÷ gross square feet ______



# The Tour

For most campuses an energy tour should begin at the campus central plant, and follow the flow of energy through the campus energy system.

## Central Plant

The following are several key points the facilities director should mention:

1. How much energy the central plant consumes.
2. How much energy it produces and in what form.
3. The condition of the central plant.
4. Its reliability, i.e., the breakdown record of the system.
5. How often it is serviced.
6. The number of people required to ensure both effective and safe operation.
7. The number of people currently operating it compared to the number of people doing so five years ago. Also, if the number has decreased, tell whether the drop in personnel has been accomplished by operating improvements, greater use of technology, or by deterioration in operations quality.
8. The safety record of the plant.
9. Replacement or renewal needs of the central plant.

## Buildings, Boiler Rooms, and Cooling Towers

The director should mention the following:

1. The condition of the pipes and distribution system.
2. The frequency of the servicing or maintenance requirements of the system, as well as the actual level of service being performed.
3. Its reliability; i.e., the breakdown record of the system.
4. The number of people required to ensure both proper and effective operation.
5. The number of people who currently maintain the systems compared to the number who did so five years ago, and the number of square feet that have been added to the systems since then.
6. Condition of the pumps, motors, and other equipment.
7. How often the filters are changed. The recommended frequency of replacement. How often the pumps and motors are serviced.

## Throughout Campus

As the group tours the campus, the condition of the plant in general should be pointed out by the facilities director. Because campus deterioration occurs over a long period of time, it often goes unnoticed by the untrained eye. What often is obvious to the director is invisible to other members of the academic community.

The director should therefore point out the following items:

1. Water stains on the interior walls and ceilings.
2. Difficulty in custodial care.
3. Missing ceiling tiles, cracked glass, broken blinds and shades.
4. Doors that do not close tightly or are in need of repair.
5. Stone and brick problems, such as missing mortar or pointing.
6. Condition of the grounds.
7. Roof problems.

Tour members should look at the campus through the eyes of a prospective student or donor. What does the environment say about the health of the campus?

## CHAPTER 2

# ■ Facilities

Energy management is an ongoing process in which you will first identify and implement energy efficiency improvements to your campus facilities and, second, monitor the effectiveness of the improvements. The direct benefits of energy management are a decrease in energy consumption and cost avoidance in your budget, while the indirect benefits are greater comfort for users of the facility and an increased knowledge of how your buildings and equipment work and how they may be used to support the institution's academic mission.

A well-designed energy management plan will take into account all the factors that affect energy use in campus buildings. These factors include the sizes, types, and ages of the buildings; the campus enrollment and the nature of the academic activities; the present condition of the buildings and systems; and the personnel and financial resources required to implement and maintain increased energy efficiency projects.

The purpose of this chapter is not to provide you with all the detailed guidance required to undertake a major retrofit of your campus, but rather to help you begin the process of developing and collecting the technical information that you will need to prepare an energy management plan. This chapter and its five exercises are treated as a single sequence of activities (see flow chart on page 33). These exercises interact with those in other sections of the workbook in order to assist the campus team to develop an energy management plan.

You should remember that energy management involves operation and maintenance of energy systems, and, we suggest here, low cost and no cost activities that improve the condition of energy equipment. At what point do you retain a professional engineering consultant to help you identify how to make more costly capital improvements? That question is difficult to answer. We suggest, however, that you work through these workbook exercises to get a broad perspective of what changes you can implement now, how much you can gain from them, and how you should manage their implementation. No doubt you will want to consult with some of the resources provided in Section IV, such as the Energy Audit and Analysis. Then, as the campus energy improvements become more clearly structured, you may want to seek professional counsel to examine specific equipment conditions that you believe require major work.

Each of the five exercises below consists of a set of instructions and a completed sample. Additional worksheet blanks are provided at the end of the workbook. The exercises will require only a calculator with basic functions of addition, subtraction, multiplication, and division.

The activities in this chapter are divided into three phases.

1. Evaluation of past and future campus energy needs and costs, including the potential impact of an energy management program.
2. Assessment of the physical and management condition of each building as it affects energy efficiency.
3. Initiation of the development of an energy master plan to implement the low cost/no cost measures and capital improvements to buildings.

## Past and Future Energy Use and Cost Analysis

Completion of exercises 1 through 4 will identify and organize your current, past, and future campus energy consumption and costs. The results will enable you to determine what impact energy will have on the budget in the future and what, if any, effect an energy management plan would have on the consumption rate.

These exercises use a concept known as the Energy Utilization Index (EUI). The EUI of a campus is the total energy use of that campus during the fiscal year, converted to equivalent British thermal units (Btus) and divided by the gross square foot floor area of the campus. The result is in Btus per square foot per year. EUIs are calculated for individual buildings when annual energy uses are known. Exercises 1 through 3 will help you calculate current, past, and future EUIs for your campus.

Exercise 4 requires the addition of weather data from the National Weather Service and some future energy costs to determine what impact an energy management plan could have on the future costs or what the lack of a plan would have on the same costs. The projection procedure also gives you a method for monitoring the progress of your energy program toward your reduction goal in terms of consumption and cost avoidance.

## Building and Campus-Wide Assessment

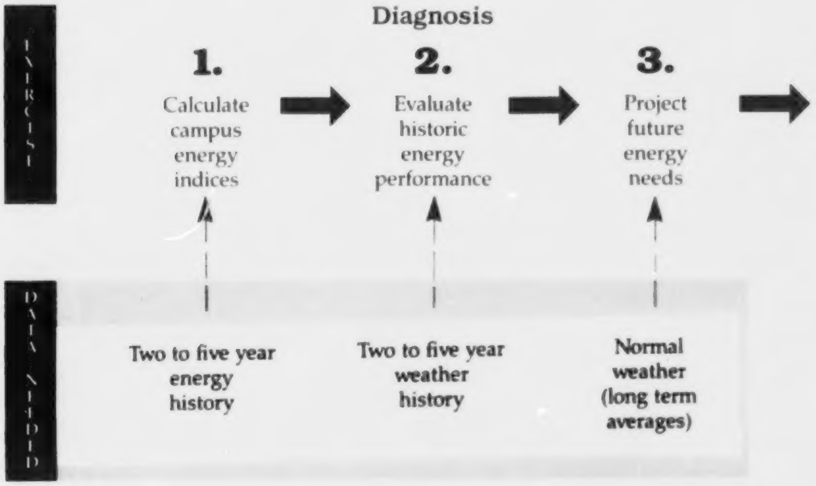
Energy management for most campuses is largely building energy management. This phase asks you to assess the physical, maintenance, and management condition of each building on campus to identify possible deficiencies. The procedure used in Exercise 5 is based on the information held in the campus management team's heads and is largely subjective in nature. However, qualifications given on the worksheet direct the subjective evaluation so that it gives you a good working picture of the campus as an energy using entity.

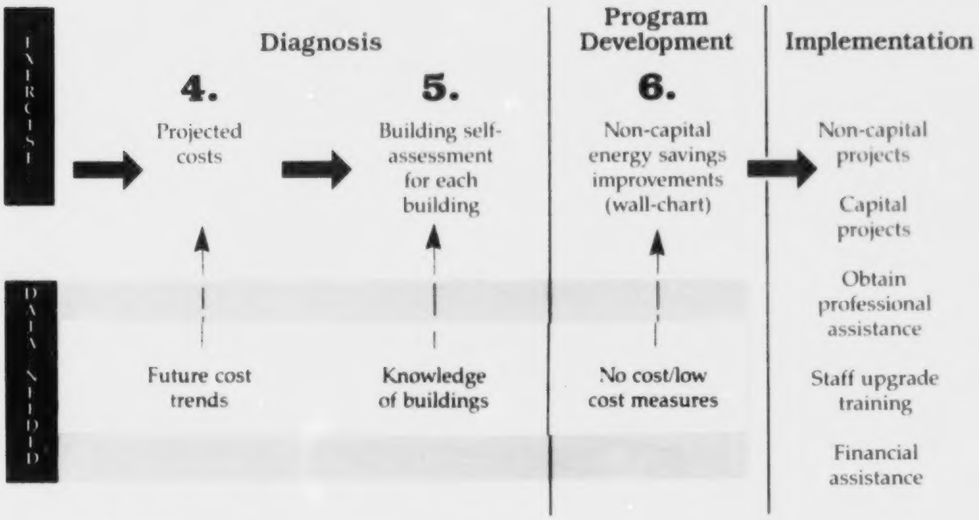
Exercise 5 has two steps. In the first step, you will look at the condition of each building in areas of capital, maintenance, operation, and academic scheduling. In the second, you will be asked to rank all campus buildings by current condition, academic usefulness, capital needs, and their management opportunities.

# Technical Support to the Campus Energy Plan

Following the self-assessment of Exercise 5 you will begin the next step in energy management for each building. For those buildings in relatively good condition, you will be expanding their assessment in Chapter 5, Exercise 6, which examines personnel management and building and equipment maintenance. This worksheet records and schedules low cost/no cost activities for your facilities crews.

If the Exercise 5 analysis identifies capital deficiencies, you will be directed to obtain professional assistance in evaluating capital improvements. Sections of other chapters and of the resources section to this workbook will help you to identify and select professional assistance as well as find financial support for a capital improvements program.


EXERCISE
Diagnosis
1.
Calculate campus energy indices
2.
Evaluate historic energy performance
3.
Project future energy needs
DATA NEEDED
Two to five year energy history
Two to five year weather history
Normal weather (long term averages)


EXERCISE
Diagnosis
4.
Projected costs
5.
Building self-assessment for each building
Program Development
6.
Non-capital energy savings improvements (wall-chart)
Implementation
Non-capital projects
Capital projects
Obtain professional assistance
Staff upgrade training
Financial assistance
DATA NEEDED
Future cost trends
Knowledge of buildings
No cost/low cost measures

## Exercise 1: Collecting Data and Creating Indices

This exercise collects data relevant to the other exercises contained in this chapter. The data is converted to the appropriate indices for use in the worksheets. Historical energy data should be collected for no less than two years and preferably for the full five years allowed by the worksheet system. The longer period of analysis provides more useful information and is less affected by the conditions of any one year.

STEP 1: Check the boxes on the Fuel Type Conversion Table 1 below that indicates the types and units of purchase for the fuels used on your campus. Check as many items as apply. The table also tells you the typical energy content of the fuel units purchased in British thermal units or Btus. This conversion will be used in Worksheet 1A.

**Table 1—Fuel Type Conversion Table**

| Fuel Type | Check Boxes | Units | Energy Content Equivalent (Btu) |
|---|---|---|---|
| Electricity | ☐ | kwh | 3,410 |
| Natural Gas | ☐ | therm | 100,000 |
| | ☐ | ccf | 103,000 |
| | ☐ | mcf | 1,030,000 |
| Propane or lpg | ☐ | ccf | 250,000 |
| #2 Fuel oil | ☐ | gallon | 139,000 |
| #4 Fuel oil | ☐ | gallon | 145,000 |
| #6 Fuel oil | ☐ | gallon | 150,000 |
| Soft coal | ☐ | short ton | 25,000,000 |
| Hard coal | ☐ | short ton | 28,400,000 |
| Steam | ☐ | mlbs | 1,000,000 |

*Note: Energy content figures have been rounded off to three significant digits.

NOTE: In completing Worksheet 1A, one worksheet for each fuel type should be filled out; make one copy of Worksheet 1A for each box checked in the Fuel Type column on the conversion table above. On each copy, fill in a fuel type, and assign the fuel a code number: 1, 2, 3, 4, ... etc.

STEP 2: Gather two to five years of historical energy data, dollars, and physical units on each fuel type checked, and enter this data in columns 1 and 2 on Worksheet 1A. Also, determine and enter the campus gross floor area in square feet during each of the recorded years in column 5. (If this historical energy data is not available in the campus records, consult your local utility for the information.) Do not record the fuel bills for the current year.

STEP 3: Examine the data you have collected. If you have obtained fuel bills for all types of fuels used in a particular year, describe all such years as Complete Fuel Years.

STEP 4: From the Fuel Conversion Table 1, obtain the Energy Content Equivalent for each fuel type, and on the appropriate copy of Worksheet 1A corresponding to this fuel type, fill in column 3 with the Energy Content Equivalent number for all Complete Fuel Years.

STEP 5: Complete column 4 by multiplying column 2 by column 3 for each fuel type in all the Complete Fuel Years.

STEP 6: For all fuel types and all Complete Fuel Years, divide the numbers in column 4 by the numbers in column 5, and place the results in column 6. Repeat this process, but divide the numbers in column 1 by the numbers in column 5, and place the results in column 7.

STEP 7: Now transfer the numbers you calculated in columns 6 and 7 to Worksheet 1B and 1C (column 6 EUI to 1B and column 7 to 1C). Note that each fuel type in the worksheet has its own column of boxes according to the fuel code number you assigned it.

STEP 8: For all the Complete Fuel Years, add the numbers in the boxes across each row and place the total in the total column on the right. This step will yield the Energy Utilization Indices and the Total Cost per Square Foot for the entire campus for all the Complete Fuel Years.

# Worksheet 1A

**Fuel Type:** ELECTRICITY

**Energy Content** 3,410 **Fuel Code No.:** 1 **Units** Kwh

| Year* | 1. Fuel Bill Dollars | 2. Physical Units Consumed | × | 3. Btus per Unit | = | 4. Btus Consumed | 5. Gross Sq. Ft. | 6. EUI Btus/Sq. Ft. | 7. Dollars per Sq. Ft. |
|---|---|---|---|---|---|---|---|---|---|
| 1990 | 68276 | 1603397 | × | 3410 | = | 5467583770 | 296550 | 18437 | 0.22 |
| 1991 | 82757 | 1753879 | × | 3410 | = | 5980727390 | 296550 | 20167 | 0.28 |
| 1992 | 81153 | 1760431 | × | 3410 | = | 6003069710 | 296550 | 20243 | 0.27 |
| 1993 | 90231 | 1793603 | × | 3410 | = | 6116186230 | 296550 | 20624 | 0.30 |
| 1994 | 117340 | 1909266 | × | 3410 | = | 6510597060 | 296550 | 21954 | 0.40 |

**Fuel Type:** # 2 FUEL OIL

**Energy Content** 139,000 **Fuel Code No.:** 2 **Units** GALLON

| Year* | 1. Fuel Bill Dollars | 2. Physical Units Consumed | × | 3. Btus per Unit | = | 4. Btus Consumed | 5. Gross Sq. Ft. | 6. EUI Btus/Sq. Ft. | 7. Dollars per Sq. Ft. |
|---|---|---|---|---|---|---|---|---|---|
| 1990 | 153222 | 273050 | × | 139000 | = | 37953950000 | 296550 | 127984 | 0.52 |
| 1991 | 143808 | 239957 | × | 139000 | = | 33354023000 | 296550 | 112473 | 0.48 |
| 1992 | 155274 | 241508 | × | 139000 | = | 33569612000 | 296650 | 113201 | 0.52 |
| 1993 | 250786 | 242564 | × | 139000 | = | 33716396000 | 296550 | 113695 | 0.85 |
| 1994 | 290100 | 240202 | × | 139000 | = | 33388078000 | 296550 | 112588 | 0.98 |

*Complete for historical years only.

# Worksheet 1B: Total Campus Energy Indices

## Energy Utilization Index (EUI)

Energy Utilization Index (EUI)
(From Worksheet 1A, Column 6)
(Historical)

| Year | Fuel 1 | + | Fuel 2 | + | Fuel 3 | = | EUI |
|---|---|---|---|---|---|---|---|
| 1990 | 18437 | + | 127984 | + | -0- | = | 146421 |
| 1991 | 20167 | + | 112473 | + | -0- | = | 132640 |
| 1992 | 20243 | + | 113201 | + | -0- | = | 133444 |
| 1993 | 20624 | + | 113695 | + | -0- | = | 134319 |
| 1994 | 21954 | + | 112588 | + | -0- | = | 134542 |

# Worksheet 1C: Total Campus Energy Indices

## Total Cost per Gross Square Foot

| Year | Total Cost Per Gross Square Foot (From Worksheet 1A, Column 7) (Historical) Fuel 1 | + | Fuel 2 | + | Fuel 3 | = | Total Cost Per Gross Sq. Ft. |
|---|---|---|---|---|---|---|---|
| 1990 | 0.22 | + | 0.52 | + | -0- | = | 0.74 |
| 1991 | 0.28 | + | 0.48 | + | -0- | = | 0.76 |
| 1992 | 0.27 | + | 0.52 | + | -0- | = | 0.79 |
| 1993 | 0.30 | + | 0.85 | + | -0- | = | 1.15 |
| 1994 | 0.40 | + | 0.98 | + | -0- | = | 1.38 |

# Exercise 2: Evaluation of Past Energy Performance

**This exercise takes data developed in Exercise 1, adds new information, and helps you analyze your campus's past energy performance. By adjusting past energy uses for weather, using one of the two alternate procedures, the impact of campus actions on energy use can be seen. If you have an effective energy management program, you will be able to see the impact of your energy saving activities.**

At this point, it is useful to introduce a bit of philosophy. It is more practical to work with energy and fuel types rather than costs when developing energy analyses and management policies, because while your efforts may have an impact on campus energy consumption, these activities do not determine the cost of fuel. You can best influence your energy expenditures by controlling the amount of energy that your campus uses. Thus, in all of these analyses, the cost of energy is treated as the last step, almost as an outcome of general use.

STEP 1: Obtain weather data, that is, the Heating and Cooling Degree Days for the years for which you have Complete Fuel Years. The long-term (30-year) normal degree days must be obtained as well. These data can be obtained from a major weather bureau office (i.e., a major airport in your region). The data may also be obtained from a booklet published by the National Weather Service called *Climatological Data,* a magazine-like publication issued each month for each state. Many universities and large city libraries have collections of this document for their states. The July issue totals annual Heating Degree Days, while the Annual Summary does the same for Cooling Degree Days.

Heating and Cooling Degree Days are a means of measuring the amount of heating and cooling required due to local climatic conditions. Degree days represent the difference between a daily average temperature and a given base point, often chosen as 65°F. For example, on a day when the high temperature is 50°F and the low is 40°F, the average temperature is (50°F + 40°F)/2, or 45°F, and the "base 65" degree days are 65°F minus 45°F, or 20 degree days. When the average is below the base point, the result is a Heating Degree Day; when the average is above the base, it is a Cooling Degree Day. Degree days are typically totaled for the month and for the year.

STEP 2: Enter the Heating (column 1) and Cooling Degree Days (column 2) for your local area in the appropriate boxes on Worksheet 2A. Add the Heating and Cooling Degree Days to get the total degree days, and place the number in column 3. Transfer from Worksheet 1B the EUI for each Complete Fuel Year to column 4 on Worksheet 2A.

STEP 3: Select an appropriate vertical scale for Worksheet 2B. This scale should accommodate the largest EUI figure generated on Worksheet 2A. It may be useful to drop the last three digits of the EUIs, that is, converting 138,350 Btu to 137 KBtu. Scales should range from 0 to 50, 0 to 100, 0 to 150, 0 to 200, or 0 to 250 KBtu with the appropriate intermediate points. Next, plot the annual EUIs for each Complete Fuel Year on Worksheet 2B. Connect the points on Worksheet 2B with lines; a colored ink is sometimes helpful, but it may not reproduce well on a copying machine.

STEP 4: Climatic conditions influence the amount of energy used each year. In order to understand changes in energy use due to the weather, the next step creates "Weather-Adjusted EUIs." This may be done using either linear regression or averaging.

a) Linear Regression: This is the preferable procedure, since it considers energy use to have two primary variables: 1) climate-related factors, and 2) fixed components. However, the calculation of linear regression factors requires a pocket calculator, a business manager, and a faculty member or willing student with statistical capacities. You should have data for at least four Complete Fuel Years to attempt this approach. A linear regression will produce a formula that looks like this:

$$Y = A + B \text{ x } X$$

where Y is the Actual EUI (column 4), X is the Total Degree Days and x is used as a symbol for multiplication. If this method is used, enter the factors A and B found by calculation on Worksheet 2A at the bottom and place a check in the box provided.

b) Averaging: This is much simpler to calculate but faulty in that it assumes all energy usage to be weather related. This calculation involves only adding the EUIs and the Total Degree Days. The formula for calculating the average factor is:

$$\begin{array}{ll} \text{EUI (1st year) + EUI (2nd year) + EUI (3rd year)} & \text{[EUI from Worksheet 1A]} \\ \cline{1-1} \text{DD (1st year) + DD (2nd year) + DD (3rd year)} & \text{[DD from Worksheet 2A]} \end{array}$$

where EUI and DD are provided only where both are greater than zero. (If the EUI and DD are less than or equal to zero, do not use them.) If this method is used, enter the factor Average EUI divided by the DD on Worksheet 2A, column 3, at the bottom and place a check in the box provided.

STEP 5: Using the actual Total Degree Days for each year (column 3), calculate on Worksheet 2A the Weather-Adjusted EUI for each year using one of these formulas:

WEATHER-ADJUSTED EUI =
A + B x Total Degree Days, or

WEATHER-ADJUSTED EUI =
Average EUI/DD x Total Degree Days

Take the result of the calculation and record it in column 5 for Weather-Adjusted EUI.

Plot the points from column 5, Worksheet 2A on Worksheet 2B in the appropriate years and connect them. You may use a different color line to connect them, or use a dashed line instead of a solid line.

STEP 6: An initial assessment of the impact of campus actions on energy use may be obtained by comparing curves developed in Steps 3 and 5. The curve of actual EUIs represents actual performance while the curve of Weather-Adjusted EUIs removes the climate effect. If the actual is less than the weather-adjusted value, then the campus reduced its energy use; if the latter is true, the campus lost ground relative to its performance in previous years. What you should find, if the campus has improved energy efficiency, is that the actual EUI points are below weather-adjusted EUIs in later years, and above for earlier years.

STEP 7: A comparison of your actual EUI with that of a college similar to yours but operated at a reasonably high energy efficiency level will now be conducted. Figure 2A, the Guidelines Energy Use Chart, can be used to obtain estimates of Guideline EUIs for various combinations of cooled and non-cooled campuses. This guideline level represents the performance of the existing plant, fully maintained, and scheduled and operated for maximum energy efficiency.

Figure 2A represents an analysis of guideline conditions at a typical college campus (approximately 300,000 gross square feet of building space) in various climate zones.

For each Complete Fuel Year, find the Heating Degree Days from Worksheet 2A (column 1), look up the corresponding Guideline EUI in Figure 2A, and plot this EUI on Worksheet 2B. Connect the points with a line of distinct color or type. The difference between this line and the actual EUI line represents the amount of energy waste during previous years. Any decline in wasted energy during the last few years that you observe reflects the positive result of your energy saving improvements.

At this point you have completed a simple but effective analysis of your institution's historical energy usage. This data can be useful in preparing an energy management proposal to the college president and board.

## Worksheet 2A: Weather Adjusted EUI/Guideline

| Year | 1. Heating Degree Days | + | 2. Cooling Degree Days | = | 3. Total Degree Days | 4. Actual EUI | 5. Weather-Adjusted EUI | 6. Guidelines EUIs from Fig. 2A |
|---|---|---|---|---|---|---|---|---|
| 1990 | 4557 | + | -0- | = | 4557 | 146421 | 136851 | 99000 |
| 1991 | 4257 | + | -0- | = | 4257 | 132640 | 137035 | 96000 |
| 1992 | 4500 | + | -0- | = | 4500 | 133444 | 136886 | 98000 |
| 1993 | 4838 | + | -0- | = | 4838 | 134319 | 136679 | 101000 |
| 1994 | 5114 | + | -0- | = | 5114 | 134542 | 136510 | 103000 |
| Normal** (Long term) | 4654 | | | | 4654 | | 136792 | 100000 |

*Calculation method for weather-adjusted EUI *(Check one)*

☑ Linear Regression
enter factors: A = 139,640, B = 0.612
EUI = A + B × X

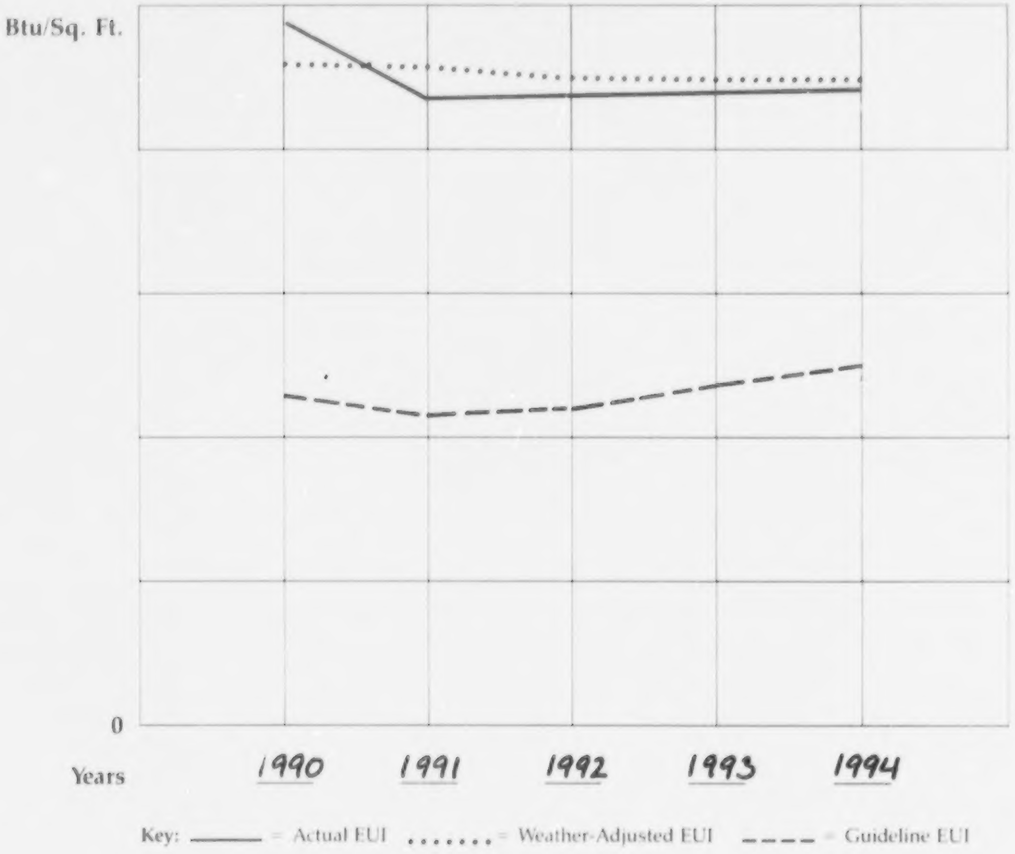
☐ Averaging per Degree-Day:
enter factor [Avg EUI/DD] = ________
EUI = DD × (Avg EUI/DD)

**See Step 1, Exercise 3.

# Worksheet 2B: EUI/Guideline

**Vertical Axis Options**

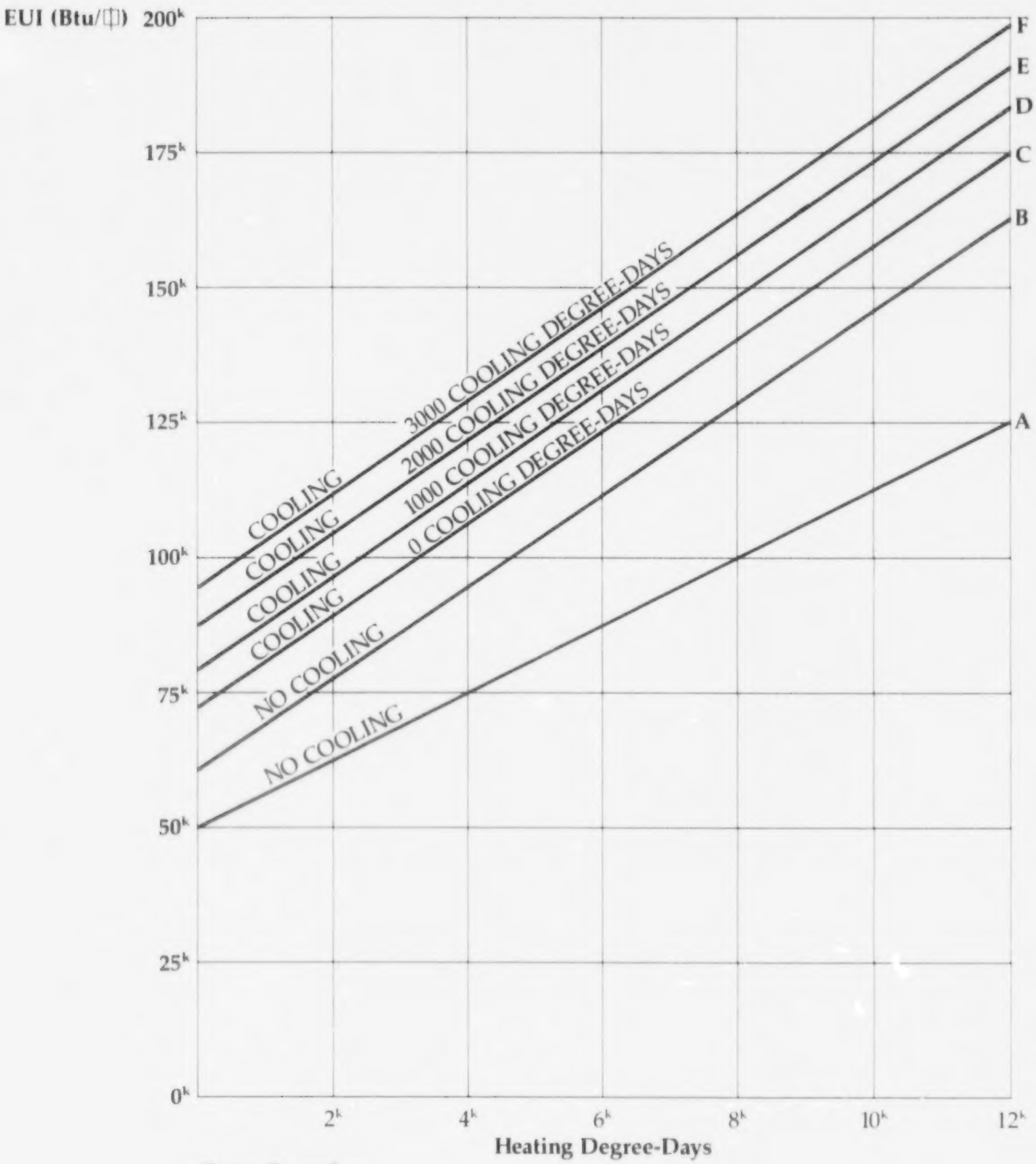
1. Full scale 0-50; each line equals 10 KBtu
2. Full scale 0-100; each line equals 20 KBtu
[✓ 3.] Full scale 0-150; each line equals 30 KBtu
4. Full scale 0-200; each line equals 40 KBtu
5. Full scale 0-250; each line equals 50 KBtu
6. Full scale 0-______.



## Figure 2A: Guideline Energy Use Chart

Figure 2A represents the anticipated efficient energy use of a typical college located in various climate conditions. It is expressed as an EUI.

To use the table, obtain the average annual or normal Heating and Cooling Degree Days for your location. Read up from the point on the Heating Degree Days axis on the chart to the line which represents how much of your campus is artificially cooled. Note that if there is cooling, you will also have to read up to the line representing the annual Cooling Degree Days. Reading across from the appropriate line, you will find an EUI figure in thousands of Btus per square foot per year. This represents an estimate of the typical campus EUI under the given Heating and Cooling Degree Days.



**Curve Formulae**

**Curves**

A EUI = 50000 + 6.25 × HDD
B EUI = 60000 + 8.50 × HDD
C EUI = 72000 + 8.50 × HDD
D EUI = 80000 + 8.50 × HDD
E EUI = 88000 + 8.50 × HDD
F EUI = 96000 + 8.50 × HDD

**Note:** For curves C, D, E and F, 80 percent of campus assumed cooled—gym, supporting facilities and shops not cooled.

## Exercise 3: Projected Future Energy Use

In this exercise you will do three things to help you develop projections of future campus energy needs. These are:

1. Project future energy use for five years at your present rate of consumption.
2. Project future energy use for five years at the "guideline" level of improved operations, maintenance, and space scheduling.
3. Identify and project the impact of a cost-effective capital modifications program for energy-using systems.

STEP 1: The best available estimate of future weather trends is to assume that future climatic conditions will be similar to the long-term average. Therefore, your future energy use at present rates of consumption will be a continuation of your Weather-Adjusted EUI figures into the future, using normal weather data. Turn back to Worksheet 2A for a moment, and:

> a. Write the long-term Average or Normal Heating Degree Days in column 1 on the row marked "normal." To calculate: total the columns and divide by the number of entries. Do the same for Average Cooling Degree Days in column 2, and write the total of columns 1 and 2 in column 3.
>
> b. Using whichever method you adopted for calculating a Weather-Adjusted EUI (step 5, page 42), calculate an Average Weather-Adjusted EUI, and place this number in column 5 for the normal row.

STEP 2: On the "Year 0" line on Worksheet 3, plot the Normal Weather-Adjusted EUI just calculated. Project this point horizontally as a line to the + 5 axis.

STEP 3: Similarly, plot the normal value of the Guideline EUI from Figure 2A on the Year 0 axis and project this line out to the Year + 5 line. This line represents future energy use with the impact of fully successfully operation and maintenance and scheduling modifications.

STEP 4: In general, a capital improvements program can probably save your insitution about 15 percent of Guideline energy using cost-effective measures. Your own experience and that of your campus may indicate an increase or decrease in this estimate. Calculate this level, called the Capital Modifications EUI by:

Capital Modifications EUI = Guideline EUI
(Column 6, Worksheet 2A, page 42) x (1.0 – Capital percent)
and plot this line from the Year 0 to the Year + 5 axis.

STEP 5: In this step you will develop the objective of your energy management program, including annual goals. Follow these procedures:

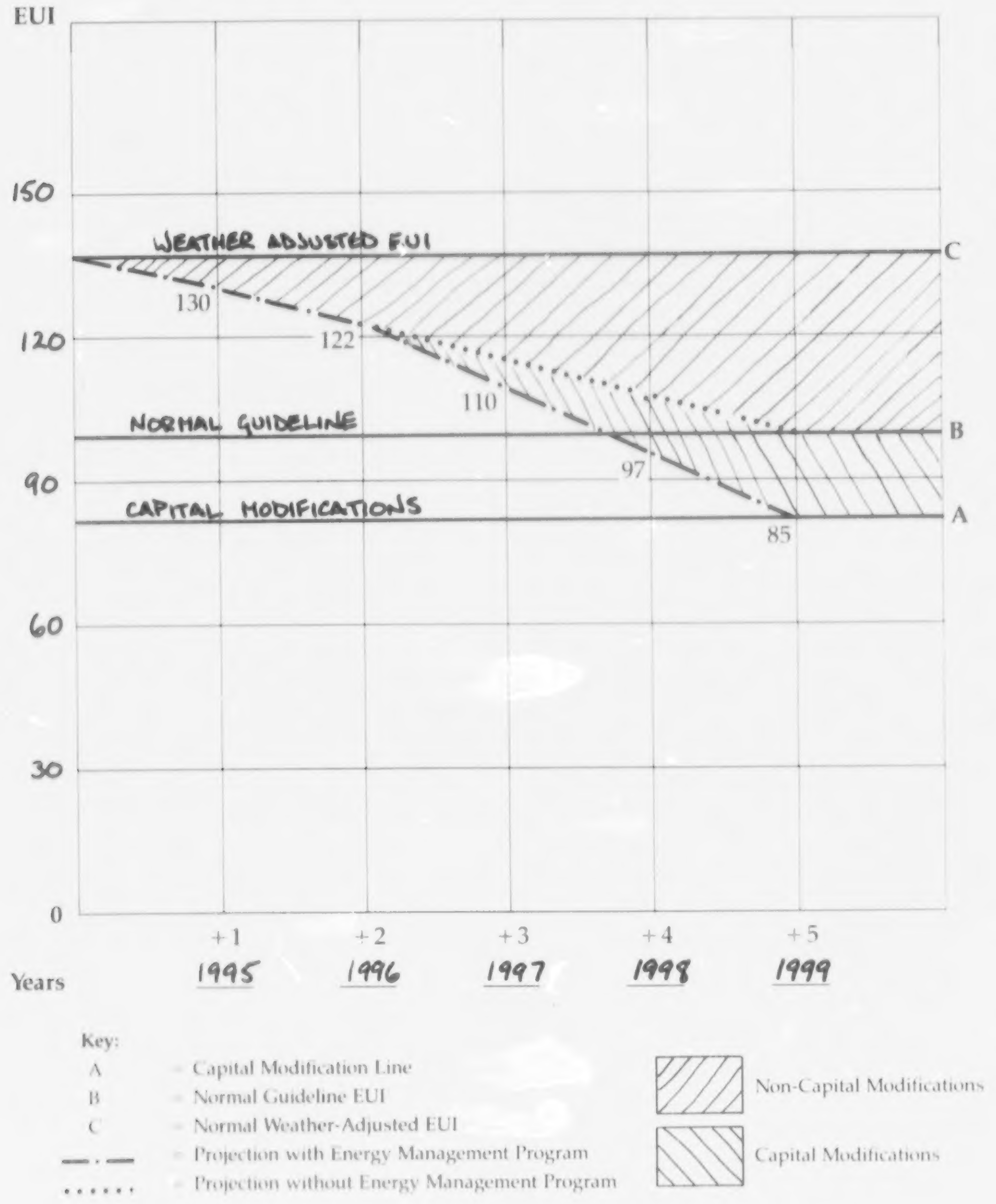
a. Select a time frame for recovering the indicated low cost/no cost (operation and maintenance) potential (the area between the Weather-Adjusted and Guideline EUI lines). As a general rule, try to eliminate about 5 percent of the Total Energy Use by low cost/no cost operation and maintenance actions each year (e.g., if you have a 20 percent potential to recover it in four or five years). A listing of low cost/no cost measures is in the Resource section, pages 112-115.

Locate the point where the axis for the year in which full recovery is completed intersects the Guideline EUI line, and lightly connect this point with the Weather-Adjusted EUI line on the Year 0 axis. This represents annual recovery.

b. If you plan a capital improvements program to obtain further energy savings, you will now plot the impact of this program. As it takes some time for such a program to begin showing savings, you can have the impact begin to appear at the end of either Year + 1 or Year + 2. From the intersection of this year axis with the line plotted in (a) above, draw another light line to the point where the Capital Modifications EUI line crosses the Year + 5 axis. Normally this line will be entirely below the line plotted in (a) above. If it isn't, plot a line so that you can see the total impact of both capital and noncapital modifications in each year.

c. The final step in preparing program goals is to go over the line representing the impact of your program with a heavier color or line. This line represents the total impact of both capital and noncapital modifications on your future energy use. This line will typically be a combination of the lines plotted in (a) and (b). Remember that the only way this line can go below the Guideline EUI line is to include a capital modifications impact in it.

## Worksheet 3: Projected Future Energy Use



# Exercise 4: Trend Analysis of Energy Costs

This exercise makes use of the work done on preceding worksheets plus some new information to analyze campus energy costs. In this exercise you will:

1. Prepare a graphic analysis of past energy costs on your campus.
2. Project future energy costs for five years if no energy management program is implemented.
3. Project the impact of the five-year energy management program defined in Step 5 of Exercise 3.

STEP 1: Using the total cost per square foot data from Worksheet 1C, plot the values for all past Complete Fuel Years on Worksheet 4B on the historical side. Connect these points with a line of distinctive color or type.

STEP 2: On Worksheet 4A, put a check to the left of the latest year for which you have complete fuel data. In column 1 of Worksheet 4A, write in the Actual EUI from Worksheet 1B, for *this year only*. Write in column 2 the Total Cost per Square Foot from Worksheet 1C, for *this year only*. Now divide the number in column 1 by that in column 2, and place the answer in column 3 for this year only.

STEP 3: Complete column 4 for the latest Complete Fuel Year and six additional years by writing in a fuel inflation factor:

a. Obtain an estimate of fuel inflation rates (explained below);

b. Convert the inflation rate to a decimal equivalent (for example, 10 percent becomes 0.10), add 1.0 to the number (thus 1.10), and write the number in column 4 for the appropriate year.

Obtaining reliable estimates of future fuel prices is difficult unless your institution has long term fuel purchase agreements. Also, this exercise calls for an average fuel price inflation rate, which ignores how much of each fuel you use. For inflation rates we suggest using the most recent *Annual Energy Outlook*, published by the Energy Information Administration, U.S. Department of Energy. This report is published annually and is available from the Superintendent of Documents, U.S. Government Printing Office.

STEP 4: For five years after the last Complete Fuel Year, divide the Btus per Dollar value for the preceding year (column 3) by the inflation factor for the preceding year (column 4), and put the result in column 3 for the next year.

STEP 5: At the bottom of the Worksheet 4A, fill in the Normal Weather-Adjusted EUI as recorded at the bottom of column 5 on Worksheet 2A. Now divide this number by the Btus per Dollar value in column 3 for each of the five years after the last Complete Fuel Year. Place the result of this division in column 5 on the appropriate row for each year.

STEP 6: Plot the values just calculated in column 5 on Worksheet 4B, and join them with a line.

STEP 7: From Worksheet 3, for each year after the last Complete Fuel Year where the graph exists, estimate the EUI that you expect to achieve with improved management of energy and capital investment. Write these values in column 6 on Worksheet 4A, in the appropriate row.

STEP 8: Now, for each year after the last Complete Fuel Year, divide the number in column 6 by the value for Btus/Dollar in column 3, and place the results in column 7.

STEP 9: Plot the values in column 7 on Worksheet 4B on the projected side, and join them with an appropriate colored line. For any given year, the difference between the line drawn in Step 6 and the Step 9 line is the dollar value of avoided fuel costs attributable to the energy management program.

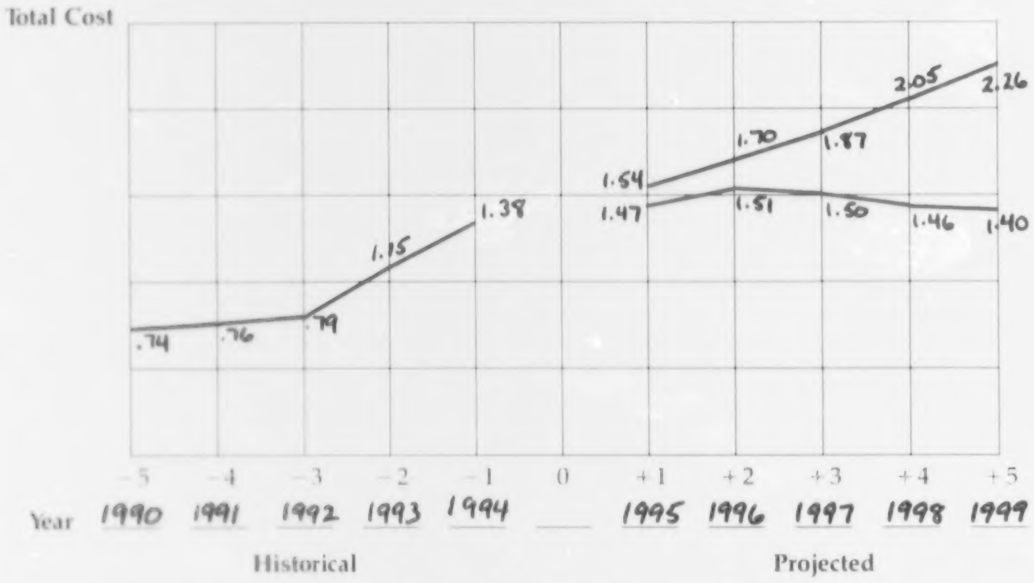
## Worksheet 4A: Cost Calculations

| Year | 1. Actual EUI | 2. Total Cost/ Sq. Ft. | 3. Btus per Dollar | 4. Inflation Factor | 5. Future Cost No Change | 6. Energy Management EUI | 7. Energy Management Costs |
|---|---|---|---|---|---|---|---|
| This year | 134542 ÷ | 1.38 = | 97494 | 1.10 | | | |
| 1995 | | | 88631 | 1.10 | 1.54 | 130,000 | 1.47 |
| 1996 | | | 80574 | 1.10 | 1.70 | 122,000 | 1.51 |
| 1997 | | | 73249 | 1.10 | 1.87 | 110,000 | 1.50 |
| 1998 | | | 66590 | 1.10 | 2.05 | 97,000 | 1.46 |
| 1999 | | | 60536 | 1.10 | 2.26 | 85,000 | 1.40 |

[1] Normal Weather-Adjusted EUI: 136792

[2] Normal Weather-Adjusted EUI: (See Worksheet 2A)

## Worksheet 4B: Cost Calculations Graph



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## Exercise 5: Assessment of Present Energy Use

The evaluation of past, present, and future energy requirements serves as the base for the next set of exercises. In this section, you will be asked to "grade" the current condition and operational procedures for each building on campus. This grading process will be accomplished by using a set of criteria that is commonly used as a standard by the academic community.

In grading the campus buildings and their energy systems, you will be asked to consider each in terms of four areas: 1) functional condition, 2) general condition, 3) capital investment potential, and 4) management condition. Once you have completed this grading process, you will then begin to "prioritize" which energy management improvements should be implemented first.

STEP 1: For each building you plan to evaluate, make a copy of Worksheet 5A. On the top line of each form, fill in the name of a building. Then for each building, complete the following steps.

STEP 2: Review the use of the building, and identify as many functional uses as you can for which specific spaces in the building are assigned. This information is for your own use when you or others are reviewing the sheets later.

STEP 3: Estimate the total square feet in the building, and the amount of this space that is assigned to specific functions.

STEP 4: Grade the overall usefulness of the building for the functions you just identified according to the following formula:

| Equivalent Academic Grade | Grading Criteria* | Grade Point |
|---|---|---|
| A | This is an optimum facility of this type | 4.0 |
| B | This is an adequate facility of this type | 3.0 |
| C | This is a fair facility of this type | 2.0 |
| D | This is a poor facility of this type | 1.0 |
| F | This facility is largely worthless for this purpose | 0.0 |

*The approach used in this survey and especially the "Grading Criteria" have been derived in part from Harvey H. Kaiser's *Facilities Audit Workbook: A Self-Evaluation Process for Higher Education*. For a complete self-analysis of facility and capital needs, the reader is referred to Kaiser's publication *The Facilities Audit: A Process for Improving Facilities Conditions* (APPA, 1993).

STEP 5: Grade the general physical condition of the building according to the following table:

| General Condition | | |
|---|---|---|
| A | Good Condition—no major repairs or renovations needed | 4.0 |
| B | Fair Condition—repairs and renovations needed in the next 6 to 10 years | 3.0 |
| C | Poor Condition—repairs and renovations needed in the next 2 to 5 years | 2.0 |
| D | Unsatisfactory Condition—repairs and renovations required immediately to prevent severe damage, eliminate safety hazards, or to comply with building codes and ordinances | 1.0 |
| F | Terminate—demolish or dispose of facility; the condition of the facility is beyond repair. | 0.0 |

STEP 6: Grade the various energy systems in the building with respect to the potential for capital investment according to the following table:

Capital Investment

| Equivalent Academic Grade | Grading Criteria* | Grade Point |
|---|---|---|
| A | Satisfactory | 4.0 |
| B | Requires restoration, cost no more than 25 percent of total replacement cost | 3.0 |
| C | Requires major modification, cost betweeen 25 and 30 percent of total replacement cost | 2.0 |
| D | Requires major remodeling, cost greater than 50 percent of total replacement cost | 1.0 |
| F | System or component is totally unsatisfactory and cannot be remodeled; should be replaced | 0.0 |

We have written this exercise with the expectation that you can recruit qualified resources on campus to attempt a "first pass" at assessing the capital investment needs of energy equipment. Nevertheless, in your inspection rounds you may encounter situations where you are not sure what grade a piece of equipment should receive. Outside professional help is needed. If your budget allows for it, note all of the "questionable" situations, and hire a consultant to examine them with you.

For specific systems, you might consider the following criteria in your preliminary site inspection tour (if there is no such system, skip the criteria):

- *Roof insulation:* age of the roof, R-value of insulation, condition of insulation
- *Wall insulation:* R-value of insulation, ease of increasing R-value
- *Wall thickness:* air leakage around pipe openings, wall cracks, etc.
- *Window frames:* tightness of fit in walls, gasket and weather stripping condition
- *Window glazing:* single or double glass, no broken panes, gaskets and weather stripping at operable panels
- *Exterior door tightness:* automatic closers in use, gaskets and sweeps to minimize leakage, tightness of frames in walls
- *Boilers:* age, condition, efficiency, maintenance condition, reliability
- *Furnaces:* age, condition, reliability, control of outside air use
- *Chillers:* age, condition, appropriate size for loads, replacement potential
- *Window or through wall units:* amount of use, efficiency relative to a newer unit, potential for replacement by a larger building system
- *Heating/Cooling Distribution Systems:* length and exposure to pipe runs, quality and condition of pipe insulation, size and condition of the pumps, potential for variable pumping, condition of radiators and other distribution terminals.
- *Ventilation fans and dampers:* size of fans, condition of motors, belts and fans, condition and type of filtering, closure of dampers, replacement of fans and dampers with more efficient units
- *Lighting systems:* age and type of lighting, levels adequate for task lighting, group relamping, potential for improving/switching plans
- *Domestic hot water:* usage reduced by water restriction devices, condition and amount of tank and pipe insulation, tightness of pipes, separate heaters available when not heating

STEP 7: Grade the management conditions according to the following table:

**Management Conditions**

| Equivalent Academic Grade | Grading Criteria* | Grade Point |
|---|---|---|
| A | Satisfactory performance | 4.0 |
| B | Some improvement possible and likely if suggested | 3.0 |
| C | Major improvement possible, great effort required | 2.0 |

| Equivalent Academic Grade | Grading Criteria* | Grade Point |
|---|---|---|
| D | Condition basically out of control, but technical systems allow improvement of the situation | 1.0 |
| F | Conditions out of control and improvement not possible with existing technical systems. If this grade is given, be sure that the grade given to the appropriate systems in the Capital Investment Evaluation is correspondingly lowered | 0.0 |

For specific systems, you may want to consider the following issues:

- *Efficiency of space scheduling and use:* few hours with only a few rooms in use, rooms used for acceptable purposes only (usually), cooperation in scheduling with energy staff
- *Proper control of lighting:* off in the empty rooms, off or reduced, if possible, when sufficient natural lighting
- *Space temperature during occupied periods:* appropriate settings, reliability of the controls
- *Operating schedules and conditions of major heating and cooling systems:* set points, dampers, etc.
- *Operation of the building when not in use:* lights off, heating and cooling set back or shut down, etc.

STEP 8: When you have completed grading a building, summarize the four overall grades on the last page of Worksheet 5A. You can calculate an overall average grade at this point, but since the four grades reflect distinctly different sets of issues, you should consider them separately.

Perform a series of "what ifs" to determine your next action. For example, if the functional evaluation grade or the general condition grade is below 2.0, have you considered replacing the building?

If both these grades are below 2.0 and if

- The capital investment grade is less than 3.0, consider adding a capital budget item for restoration and energy upgrades.
- The capital investment grade is greater than or equal to 3.0, go to an operations and maintenance analysis using the chart you develop in Worksheet 3 and the low cost/no cost measures in the resource section. The rule of thumb is to take care of the low cost/no cost measures before undertaking the capital modifications.

# Worksheet 5A: Building Grade Point

Building name or campus number: ______________________________

Types of assignable space:

☐ Classroom
☐ Laboratory
☐ Study
☐ Special
☐ General Use
☐ Supporting
☐ **Healthcare**
☐ **Residential**
☐ **Office**
☐ **Unclassified**

Notes: ____________________________________________

____________________________________________

Size: Assignable Square Feet: ________
Total Square Feet: ________
Divide Assignable Square Feet by Total Square Feet to obtain the ratio:
________ : ________

### SUMMARY GRADES:

Functional Evaluation ______
General Condition ______
Capital Investment (Average) ______
Management Condition ______
Functional Condition Evaluation ______
General Condition ______

### CAPITAL INVESTMENT EVALUATION

Passive systems:

Roof insulation ______
Wall insulation ______
Wall tightness ______
Window frames ______
Window glazing ______
Exterior door tightness ______

Active systems:

Boilers ______
Furnaces ______
Cooling: chillers ______
Cooling: window units, thru-wall units ______
Heating/cooling distribution ______
Ventilation fans/dampers ______
Lighting ______
Domestic hot water ______
Special facilities (list) ______

**Worksheet 5A, Continued**

**Total Capital Investment Grade Point** ________
Total number of grades ________
Average Capital Investment Grade ________

**MANAGEMENT CONDITION EVALUATION:**
Efficiency of space scheduling ________

Energy awareness of building staff and users:
General awareness ________
Closing exterior doors, including vestibules ________
Appropriate use of windows ________
Proper control of lighting ________
General maintenance of building systems:
Heating plant, if in the building ________
Cooling plant, if in the building ________
Control systems for heating/cooling ________
Lighting (fixtures cleaned) ________
Space temperatures during occupied hours ________
Operating schedules and conditions of major heating/cooling systems ________
Operation of building when vacated ________
Building energy manager (if any) ________

**Total Grade Points for Management:**
Number of grades included in the total: ________
Average Management Grade: ________

## Scoring and Developing a Priority List

To complete Worksheet 5B, the scores for individual buildings developed on the building self-assessments (Worksheet 5A) will be used to identify facilities that require priority energy management work. In any category, those buildings receiving failing grades, that is, grades below 1.0, are buildings that will require major and costly repairs. Therefore, the continued use of buildings in this category should be carefully reviewed.

Several different ranking criteria are listed in the following set of instructions. This set of ranking criteria should be used for each building. In all rankings, buildings should be listed from the lowest grade point to the highest. This will place those buildings warranting the most attention at the top of your priority list. To complete this worksheet, consult the grade results from Worksheet 5A.

### Ranking Criteria

- *Building's overall grade point score:* Provides a general picture of the campus facilities' capital, maintenance, and operating problems in terms of energy. Buildings with a "soft C" (a grade point score of 2.0 or less) should be considered as major problems to the campus.
- *Functional evaluation grade point score:* Indicates the value of the building, in its present condition, to the campus.
- *General condition grade point score:* Provides an identification of those buildings that should be abandoned, will require major repair, or will be useful for a few more years. If the building receives a score below a "C," you should consider replacing it with a more efficient facility. Buildings receiving a general condition score of "A" or "B" will provide years of additional service if properly maintained.
- *Management condition grade point score:* This criterion identifies areas where existing staff and expertise should be used immediately to improve the efficiency of the facility. Buildings that receive a very low General Condition score are not worth investing additional management time, neither are those with a low Capital score, which will require substantial financial resources to repair.
- *Capital investment grade point score:* This criterion identifies those buildings which require significant funds to improve their efficiency. Such expenditures may be necessary prior to any management activities so that these activities can be effective. Again, if the General Condition score is very low, you probably will want to wait until a full renovation of the facility is undertaken or else discontinue use of the building. If the Functional rating is high, you may want to implement the energy saving improvements quickly in order to achieve immediate energy savings.

## Scoring Worksheet Instructions

STEP 1: Sort through the Worksheet 5A forms and discard those for buildings that are either to be demolished or are scheduled for major renovations soon; their Functional or General Condition grades should be low.

STEP 2: Order the remaining building worksheets according to their overall grade point score in reverse order—lowest score first. Prepare a list of these buildings with the overall grades listed on the left.

STEP 3: On Worksheet 5B, fill in the building grades for capital investment evaluations and management conditions.

STEP 4: Working with the capital investment grades, develop priorities for undertaking capital improvements in the buildings, and flag those buildings for which management improvements should wait for the completion of the capital investments. Transfer these "flags" to the management condition guides.
STEP 5: Review the management condition grades, and develop priorities for instituting improvements in the management of buildings requiring changes.

You may have noticed that this exercise of ranking projects emphasizes a different criterion for investing in building energy improvements. The emphasis here is on putting highest priority on the worst situations that are recoverable (that is, ignoring buildings that are either beyond repair or require major, complete overhauls—an effort that is beyond the domain of this workbook). The popular criterion of "highest rate of return projects first" has been downplayed. In general, the worst situations will also be the ones for which the monetary return in savings per dollar invested will be the greatest. As you improve the worst situations, however, you will probably want to shift your priorities to those conditions that may not be so bad, but promise a higher rate of return.

# Worksheet 5B: Building Grade Point Rankings

## BUILDINGS RANKED BY CAPITAL INVESTMENT

| Grade Point | Building | Letter Grade |
|---|---|---|
| | | |
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## BUILDINGS RANKED BY MANAGEMENT CONDITION

| Grade Point | Building | Letter Grade |
|---|---|---|
| | | |
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## CHAPTER 3

# Financing Energy Improvements

Improving your campus's energy efficiency is a prudent and necessary response to the financial strains facing higher education institutions. Each dollar spent on energy means one less dollar is available for student assistance, faculty, books and equipment, plant maintenance, and new programs.

Prices of natural gas and electricity especially are expected to increase steadily over the next few years as a result of decontrol and the utilities' request to include the capital costs of new plant construction in their rate bases. Given a thorough audit, between $1.25 and $2.00 per square foot of cost-effective energy improvements can be made on an average campus per square foot of gross building space.

The economic impact of increased energy costs can be measured with several ratios. For your campus, calculate energy costs as a percentage of:

1. The total operating (educational and general) budget,
2. Plant operations and maintenance expenditures, and
3. Net operating revenues.

Plotting historic costs using these ratios will dramatically illustrate how energy costs have cut into funds for other purposes. Plotting future costs based on anticipated price increases will show what will happen if no efficiency improvements are made. (See Chapter 2.)

Increased energy costs have had their greatest impact on the facilities department because money for maintenance has gone to pay for energy. As a result, resources devoted to plant maintenance have directly suffered, contributing to the overall renewal or deferred maintenance problem. That problem has been estimated to represent approximately $60 billion.

Another valuable and revealing measure is energy costs as a percentage of your institution's net operating revenues. Studies have indicated that a 25 percent reduction in energy costs—a conservative goal—would more than double the operating margin of the average school.

## Energy Cost Control

Energy costs are a function of price times the quantity used. Although unit prices cannot always be controlled, energy use can through proper operation and maintenance and the installation of efficiency improvements. The facilities chapter provided you with the tools to evaluate your campus's past energy performance, determine your energy savings potential, develop better energy operation and maintenance procedures, and identify capital investments.

This chapter explains methods to finance energy projects and how to evaluate them financially. First, you are provided with a discussion of the principles of energy efficiency financing. At the conclusion of this chapter, you will develop a decision-making framework for internal policy on financing energy efficiency improvements.

# What is Energy Efficiency Financing?

Wasted energy is money lost. If we take this idea one step further—energy saved is money gained—we can view energy conservation measures as investments. Obtaining the resources to fund energy projects can be difficult. However, these efficiencies can be captured without eliminating other programs or incurring additional overall operating expenses.

## Principles of Energy Efficiency Investments

The main principle of energy efficiency financing is straightforward: energy conservation saves money, and the savings can be used to pay for the additional efficiency improvements. Financing allows for the acquisition of capital improvements without paying for their full costs all at once. Instead, payments are spread over a period of time. The objective is to structure the finance payments so that they will be less than the actual energy savings. In other words, the energy savings are used to finance the improvements. The immediate effect on your cash flow is positive. Thus, we call this "positive cash flow financing."

Financial experts would say that by making energy efficiency investments you are restructuring your energy cost "liability." This liability is your estimated future energy expense, which you calculated in the Facilities chapter. You can choose to provide for your energy needs by continuing to pay the fuel bills dictated by your current facilities operation. Or, you can make investments in improved efficiency. The goal of the investment is to achieve the least cost energy system.

It is important to understand that energy efficiency improvements do not generate revenues like conventional investments. They generate cost avoidance. Due to increasing prices, total energy costs will not necessarily be reduced by a successful program. Costs may simply hold steady in the face of increasing prices. The important point to examine is what would have been spent if no improvements were made.

## Barriers to Financing Improvements

The primary barriers to investing in energy efficiency that affect small colleges are:

1. The initial costs are too high,
2. The risks and uncertainties are too great, and
3. There is a reluctance or inability to incur new debt.

The following discussion explains these barriers and how to tackle them. Given top administrative support, these barriers can be overcome.

**Initial Costs.** Energy efficiency investments compete for limited funds with other priorities more directly related to the academic mission. Even though they offer attractive returns on investment, energy projects are often deferred in order to balance the budget and to fund other priorities. If this is your circumstance, we recommend using alternative external sources of financing. These financing options are the subject of Section II, Chapter 6.

Taking full advantage of these projects and financing options requires adopting a new attitude toward the capital budgeting process. Usually a facilities director or energy manager assumes that funds for energy projects are severely limited and will only implement projects with very quick paybacks falling within the capital budget ceiling. The astute manager should, instead, seek to identify all economical projects and then to finance them on a positive cash flow basis. This approach to capital budgeting is explained below and summarized, in outline form, in Section II, Chapter 6.

**Financing "Soft" Costs.** Even if the construction costs of a project can be financed externally, the initial "soft" or development costs of the project can be substantial and may pose a barrier. Development costs are for information, energy audits, engineering studies, design costs, and so forth. You may have had audits performed under the federal grants program, but the quality of these audits varies widely, and many require additional work or updating.

There are several practical funding strategies to meet these soft costs. First, you can earmark energy savings from the operation and maintenance program to be applied to further project development costs. Second, use building replacement reserve funds, which often exist if your buildings were financed originally with bonds or federal loans. This suggestion is explained in Section II. Third, borrow short term or utilize a financing option that incorporates the soft costs into the long-term financing. The Facilities chapter explained how to make a "ballpark" calculation of your campus's savings potential. This estimate will give you the information you need to make cost/benefit decisions on spending for soft costs.

**Risks.** The risks associated with energy efficiency investments are distinct. First, the dollar value of energy savings is uncertain due to changes in fuel prices as well as the weather's impact on energy savings. Second, the energy efficiency of investment is subject to the technical uncertainty in engineering estimates of energy savings and the performance of installed equipment. Also, actual energy savings will vary depending on how an energy system is operated and maintained. Finally, the actual savings may be difficult to verify due to monitoring problems. All of these risks and uncertainties need to be faced directly. They can be anticipated and provided for with a risk management strategy.

The effect of uncertain future energy prices can be tested with sensitivity analysis. The cash flow improvement, return on investment, and net present value financial analysis measures can be calculated by using several different estimates of future prices. (See Section II on financial analysis.) If the project is still attractive, given the most conservative assumptions on energy prices, then it should be implemented.

The technical risks must be addressed with your engineer, contractor, and equipment vendor. Consider obtaining a second opinion or engineering feasibility study. Warranties, guarantees, service contracts, and performance bonds can be obtained to assure vendor/contractor responsibility for equipment performance. Close attention must be paid to the preparation of complete and accurate specifications. In cases where equipment operation is crucial to achieving savings, as with a computer control system, operator training should be arranged with the original equipment purchase.

If the risks of energy investments weigh heavily in your decision making, they can be transferred to private business firms. Shifting risk to private firms may cost money, but it may be attractive to you to have them handle it. There are several potential arrangements: shared savings and energy services contracting, insurance and guarantees of savings, and service contracts for equipment maintenance. With the existence of these services, a campus can choose how much risk it wants to assume in the course of achieving efficiency.

To summarize, the major risks in energy efficiency investments are:

1. Sensitivity analysis,
2. Engineering review,
3. Careful procurement and contracting,
4. Follow-up operation and maintenance and monitoring plan, and
5. Transferring risks to private firms.

## The Capital Budgeting Process

Most capital budgeting decisions are made on the basis of nonfinancial criteria derived from the campus mission. Given the availability of external financing, the decision to implement an energy saving project should be made on the basis of its costs and savings. If it offers an attractive rate of return and can be financed to generate immediate cash flow savings, then it should be implemented. If the project is postponed, potential energy savings are lost and the project costs can increase.

An understanding should be developed between the business officer and the facilities director that all projects meeting certain minimum criteria should be funded. The decision-making criteria should be spelled out in an internal policy statement. If necessary, a commitment in principle from the college's board of trustees to this policy should be sought.

The objective of this policy is a commitment to fund all energy efficiency projects that are cost effective and do not disrupt the normal academic operations. The suggested criteria for cost effectiveness are:

1. The project must meet your return on investment (ROI) hurdle rate, and
2. The project must be financed on a positive cash flow basis.

First, you must establish a target rate of return. The rate may vary with specific projects depending on the risk assessment. Your endowment ROI, plus a couple of percentage points to cover risk, is a good starting point. What is important is that you think of energy efficiency improvements as investments. Resolve also to assess and consider the nonfinancial (e.g., comfort) and deferred maintenance components of an energy project.

Whenever a building is undergoing renovation or new construction is planned, energy saving measures should be included. Certain renovations will save energy (for example, reroofing or window replacement), though it is not their primary objective. Their energy cost savings can help to justify and pay for these measures. An effective energy program is a resource for your campus. Thus, capital renewal and energy efficiency work hand-in-hand.

Energy efficiency projects will consist of a range of small projects that may cost from several hundred dollars up to several hundred thousand dollars. External financing becomes more feasible, easier to arrange, and attracts favorable terms the larger the project. As a result, more options are available for the larger project or packages of projects. However, to package many small projects can take time for planning, which can delay their implementation and the capturing of energy savings. We recommend that you consider using internal funds or an established bank line of credit (even if interest rates are relatively high) to finance smaller projects ($50,000 and less) that have rapid paybacks.

Energy project financing can be rolled into any long-term financing you are undertaking. For example, if a new building is being constructed, then the energy project costs for other buildings can be included in the financing package. If the long-term financing will not be available for some time, consider obtaining short-term financing. These costs can be refinanced once the long-term funds are available. This is another approach to maximize savings by avoiding delay in installing improvements.

Financing options should also be judged with a view toward maximizing total resources available to your campus. External financing of energy projects preserves internal funds for other priorities for which external financing may not be as easily available.

# Section II: Program Development

## Chapter 4

# ■ Developing an Energy Management Consensus

## President and Business Officer

This section contains "consensus guides" for the president and business officer, and the business officer and facilities director. (Refer to Section I, Chapter 1.)

A. In filling out the questionnaire, were there items that you either had not considered before, answered tentatively, or were not sure of the answer? Which ones?

______________________________

______________________________

______________________________

B. On which items do both of you agree?

______________________________

______________________________

______________________________

C. Does the fact that you agree mean: ☐ the actions are occuring or ☐ will occur?

D. On which items do you disagree? Cite the reasons why.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

E. Are your disagreements item-specific, or do they cluster around issues such as resource allocation, operating philosophy, or personnel?

________________________________________

________________________________________

F. Does disagreement or lack of agreement on policy or the priority on any of these issues lead to benign neglect or operating paralysis?

☐ Yes ☐ No

G. List those which fall into this category.

________________________________________

________________________________________

________________________________________

H. Given the development and presentation of appropriate facility and energy information, will you commit to energy reduction and facility improvements?

☐ Yes ☐ No

I. If yes, will you make a public announcement of this commitment?

☐ Yes ☐ No

J. What action is now required of you (e.g., securing additional resources, facility support, board support)?

________________________________________

________________________________________

________________________________________

________________________________________

# Business Officer and Facilities Director

A. List the numbers of all the questions you agreed on.

B. From the above, list those items for which you both agree an action is required or solutions must be found:

C. For those items, do you have sufficient information on which to make resource allocation decisions (personnel, supplies, equipment, retrofits)? If not, list those items for which further information is required:

Use the forms in Section I to gather additional information if you have not already done so.

D. On what items do you disagree? Cite the reason why.

1.
2.
3.
4.

E. Are your disagreements item-specific or do they cluster around issues such as resource allocation, operating funds, personnel, building utilization, etc.?

F. Reviewing the list of items you disagreed on, can you identify conditions under which you could agree on any of them?

G. Can you now develop a composite list of actions that need to be taken such as:

| | | |
|---|---|---|
| Changes in building usage patterns | ☐ Yes | ☐ No |
| Establishment of a preventive maintenance program | ☐ Yes | ☐ No |
| Staff training | ☐ Yes | ☐ No |
| Presidential involvement | ☐ Yes | ☐ No |
| Greater campus awareness | ☐ Yes | ☐ No |
| Engineering analysis for selected buildings | ☐ Yes | ☐ No |

H. Which actions require changes in operating mode, but not funding?

I. Which actions require funding above that level currently available to the facilities department or institution?

J. What actions should the facilities director now take?

K. What actions should the business officer now take?

L. As detailed in Chapter 6, which financing mechanism can best meet the requirements cited above?

# Facilities Director and Operations Staff

Energy management is not performed simply by administrative fiat. Most energy related work is performed by the operating personnel of the facilities department. These workers, operators, and trades personnel are closest to the problem and, very often, to the solution.

The purpose of this section is to have these personnel identify activities and actions that reduce the campus's energy consumption. To facilitate this, a brainstorming session and planning strategy is recommended.

The purpose of the brainstorming session is to generate ideas, drawing upon each staff member's knowledge and expertise. Used in industry and other settings, it can facilitate the development of ideas, actions, and strategies that will lead to people saying, "Why didn't we think of that before?"

In addition, the process of bringing together all the personnel in the department generates enthusiasm and a cooperative or team spirit that gives the entire department and its efforts positive momentum. The end result of the brainstorming will be a list of all ideas and actions, including operation and maintenance activities, capital, and policy changes, that will reduce energy consumption. A goal might even be specified, i.e., "What can be done that will reduce consumption by 15, 20, or 25 percent?"

This session should be conducted by an individual (a facilitator) from outside the department who is familiar with group decision-making processes and is trusted by the facilities staff. Such an individual may be found in the college's personnel department or in the dean of students office.

WHO SHOULD BE INVOLVED: plant supervisors or foremen

NOTE: If the director is present, it often inhibits the staff, yet the director can also contribute much to the process. It is a judgment call only the institution can make.

REQUIREMENTS: Classroom or other space where facilities staff can be assembled; large newsprint pads, markers, refreshments.

## Process

Campus energy efforts to date should be reviewed. The question that must be addressed is: "How can the campus reach its energy reduction potential through improving operations, maintenance procedures, policy, utilization and scheduling, and finally, capital improvements?"

In brainstorming, any idea can be suggested. Nobody says, "We can't do that because...." Any idea or suggestion, regardless of how good or bad it might be, is recorded. Only after all the ideas are put out are they evaluated.

STEP 1. To start the brainstorming session and get people comfortable with the process, the group should be asked to develop or give 10 ideas or uses for one brick. (Ideas that are often generated for the brick are: blocking a tire, blocking a door, saving water in a toilet tank, etc.)

Once the group has come up with at least ten uses for a brick, they should be comfortable enough with this form to approach a serious topic.

STEP 2. The question is asked, "What can or should be done to reduce energy consumption on the campus by *x* percent?" (In this process "money" is not a solution. The group should focus on what needs to be done, not the resources required to do it.)

STEP 3. After the "storm," when the flow of ideas ends, the group should begin culling and consolidating ideas. Often, a number of ideas can be grouped together under these categories: improved preventive maintenance; consolidation or better scheduling of classes or student activities; improved communication or public relations with faculty and students. During this process, some ideas will be dropped.

STEP 4. After the ideas have been judged, the group should then categorize the ideas into operations and maintenance improvements, capital modifications, improved scheduling, policy and personnel issues. Other groupings or categories may be used, based on what is most appropriate to the institution.

Once the ideas have been categorized, they need to be ranked according to the amount of energy they will save (often best guesses), and other relevant factors. (Many ideas will involve facets of maintenance other than energy.)

The items should be ranked within each category. This can either be done by the entire group, or it can be done by "breakout groups," each assigned a category. The latter approach is recommended. Each "breakout group" then reports their priorities to the group as a whole, and final changes may or may not be made.

The final lists are then recorded. This can be done on the following worksheet. All operations and maintenance actions should be recorded on the chart on page 76 and assigned a work order number. All capital, policy, utilization, and other recommendations requiring executive approval should be presented to the business officer by the facilities director.

By using the ideas of facilities and other campus personnel, two primary objectives are accomplished. One is that staff—the people who do the actual work and who in many ways are the best informed—have given their ideas and solutions. The second is that staff commitment to the program has been attained. Because the staff will do much of the implementation, their participation is central to the program's success.

# Energy Manager and Building Users

Collegiate organizations are not hierarchical in a classic bureaucratic model. In private colleges, considerable political weight or clout is carried by the faculty. They are the primary user group. It is around the faculty that a campus builds its academic programs and reputation.

Faculty generally teach, research, and conduct most of their activities in one building—"their building." Yet the facilities department also views the building as theirs. This creates territorial tension. To facilitate the development of a plan and to relieve or to prevent tensions from occurring, the following procedure is recommended.

1. Either the facilities director or the business officer should become the energy spokesperson to the campus.

2. Using the preceding worksheets, a building energy plan should be developed using the worksheet provided in Chapter 5, detailing all the actions that can be undertaken to save energy, the savings potential, and the effect, if any, the plan would have on the user.

3. The spokesperson should meet with the key users of each campus building (faculty, building manager, etc.), and review each action. The purpose of the meeting is to get concurrence (not approval) for as many of the actions as possible. For an action to which there is an objection (e.g., closing the building at 5:00 p.m.), the objection should be noted to see if an alternative can be developed—possibly even one suggested by the faculty. This may require an additional meeting.

The purpose of the meeting is to develop a broad base of support and involvement in the energy planning process. Properly done, this will build awareness and support. While it is time consuming, the process will have a high payback in faculty and general campus support. It takes less time to build support than to overcome the opposition plan.

## Brainstorming and Planning Strategy

| O & M | Capital | Utilization | Policy/Personnel |
|---|---|---|---|

## CHAPTER 5

# Facilities Programs

## Building Energy Plans

The following sheet (which may be photocopied as needed), should be used to detail the energy plan on a per building basis. The form simply asks for the action or recommendations, their potential savings, and the source of the recommendations. For example, the sheet might list closing Hill Hall on weekends, at a projected savings of 350 gallons of oil per year, recommended by the facilities staff or a faculty member. It might also list installation of a new or separate domestic hot water heater for summer, with corresponding savings, and the source being this workbook.

### Building Energy Plan Worksheet

| Action/Recommendation | Savings potential | Source |
|---|---|---|
| | | |
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## Exercise 6: Scheduling Energy Management Activities

This worksheet will help you schedule and monitor any low cost/no cost operation and maintenance measures. (See the listing of measures on pages 112-115 and refer to the items that were developed in Chapter 2.)

## Worksheet 6: Noncapital Energy Savings Improvements

| Energy Management Measures to be Implemented | Building | Building | Building |
|---|---|---|---|
| Schedule Adjustments | | | |
| Operations | | | |
| Maintenance | | | |

## CHAPTER 6

# Financial Evaluation of Investments

By examining your institution's approach to energy efficiency investments, you pave the way for evaluating projects financially and using them to improve your institution's cash position.

The financial evaluation of energy efficiency investments (EEI) is a two-step process: 1) deciding what projects to fund, and 2) determining the best method of financing. Each energy efficiency investment needs to be analyzed on its own merits. For many institutions, the key factor influencing the decision to implement an EEI is not its economic merits but its effect on the institution's cash flow. Even a project that represents an attractive investment may not be implemented, because many business officers are conserving cash to maintain financial flexibility. However, creative financing can allow an institution to implement a project without tying up campus funds. The cash flow effect from implementing an EEI can be calculated after the means of financing have been determined.

The standard measures of financial analysis of EEIs are: simple payback period (SPP), net present value (NPV), and return on investment (ROI). These measures will be explained and the methods of calculating them demonstrated below.

## Evaluation Measures

**Simple Payback Period.** This indicates the number of years it takes for the efficiency investment to return its initial costs in the form of savings. It is the simple ratio of costs to average annual savings.

**Net Present Value.** NPV is the value of future energy savings, less all project construction and operating costs, discounted to present value. This measure takes into account the "time value of money" and anticipated changes in energy prices. The discount rate used to calculate the present value of future energy savings is the minimum acceptable rate of return of your institution. To make the NPV analysis more conservative, the discount rate can be increased. To calculate the net present value, all future cash flows, expenses, and savings related to the project need to be estimated, including additional expenditures necessary to operate and maintain the new installation. If the NPV for a proposed project is positive, then the project should be implemented. The term of analysis is usually the economic life of the project, but can be shortened to make the results more conservative.

**Return on Investment.** The ROI of a project is the discount rate which, when used to discount all present and future costs and savings from a project, brings the NPV to zero. Increasing the discount rate will reduce the NPV. ROI is calculated by a trial-and-error process, whereby different discount rates are tested until the one that reduces the NPV to zero is derived. The ROI of a project can be compared to returns from other investments. The project should be implemented if it offers an ROI comparable to other investment opportunities with equal levels of risk. The term "cost effective" refers to investments that pass the NPV and ROI criteria.

## Cash Flow

The projected annual net effect (positive or negative) on an institution's cash flow from implementing a project is the critical measure. It is dependent not only on the project's economic merits but also on how it is financed. Properly financed, an efficiency investment can generate an immediate positive cash flow improvement to your institution. If positive cash flow can be achieved, the project should be implemented.

To illustrate these financial analysis principles we will examine a sample cash flow chart. Here, a $450,000 investment—for example, an energy control system—is made that has a base year savings estimated at $150,000, a three-year payback.

Column 1 represents annual energy costs if no improvements are made. These costs are escalated at an annual rate to reflect increasing energy costs. The previous year's energy consumption and cost is used as the base year. Here, the energy price escalation rate used is 4 percent. A more refined analysis could vary the price escalation rates in different years and different energy types. All figures are nominal dollars uncorrected for inflation.

Column 2 represents annual energy costs after the improvements are made. The year 1, column 2 figure equals the column 1 figure minus the savings estimated from the improvements. This figure is then escalated using the same energy price increase rate as in column 1.

Column 3 represents the energy savings resulting from the project, i.e., column 1 minus column 2.

Column 4 represents the additional operation and maintenance costs associated with the improvements, 4 percent of the initial capital costs of the project. This cost is escalated at the anticipated inflation rate, 4 percent.

Column 5 represents the debt service payments for the energy improvements. The critical assumptions are the term of the financing and the interest rate. Here, a seven-year, 8.5 percent financing with levelized debt service is assumed. If the improvements are paid for out of current funds, then this one-time payment is registered in year 1.

Column 6 is the annual net savings or cash flow improvement resulting from the project. It equals the sum in column 3 minus the sums in columns 4 and 5.

(Note that this project, which resembles many of the opportunities available to colleges, produces positive cash flow in the first year.)

Column 7 is the present value of each year's net savings.

Column 8 is the cumulative present value. A 12 percent discount rate is used to calculate the present value, representing a typical institution's minimum acceptable rate of return on such investments.

---

### Hypothetical Cash Flow Chart

**Assumptions:**

1. Total project cost = $450,000
2. Annual energy cost savings = $150,000
3. Simple payback period = 3.00
4. Energy price escalation rate = 4.00%
5. O & M price inflation rate = 4.00%
6. Debt term (years) = 7
7. Debt rate = 8.50% (NOTE: Taxable finance lease)
8. Discount rate = 12.00%

| Year | 1. Energy Costs (Before) | 2. Energy Costs (After) | 3. Energy Savings | 4. O& M | 5. Debt Service* | 6. Net Savings | 7. Present Value** | 8. Cumulative Present Value |
|---|---|---|---|---|---|---|---|---|
| 1 | $1,000,000 | $850,000 | $150,000 | $22,500 | $87,916 | $39,584 | $35,343 | $35,343 |
| 2 | 1,040,000 | 884,000 | 156,000 | 23,400 | 87,916 | 44,684 | 35,622 | 70,964 |
| 3 | 1,081,600 | 919,360 | 162,240 | 24,336 | 87,916 | 49,988 | 35,580 | 106,545 |
| 4 | 1,124,864 | 856,134 | 168,730 | 25,309 | 87,916 | 55,504 | 35,274 | 141,819 |
| 5 | 1,169,859 | 994,380 | 175,479 | 26,322 | 87,916 | 61,241 | 34,750 | 176,568 |
| 6 | 1,216,653 | 1,034,155 | 182,498 | 27,375 | 87,916 | 67,207 | 34,049 | 210,617 |
| 7 | 1,265,319 | 1,075,521 | 189,796 | 28,470 | 87,916 | 73,412 | 33,208 | 243,825 |
| 8 | 1,313,932 | 1,118,542 | 197,390 | 29,608 | 0 | 157,781 | 67,781 | 311,589 |
| 9 | 1,368,569 | 1,163,284 | 205,285 | 30,793 | 0 | 174,493 | 62,924 | 374,513 |
| 10 | 1,423,312 | 1,209,815 | 213,497 | 32,025 | 0 | 181,472 | 58,429 | 432,942 |

TOTAL SAVINGS: $915,365.

* 7 years, 8.5% interest, taxable finance lease assumed.

** 12% annual discount rate is used for the present value calculation.

## Working with the Financial Evaluation

The key variables in the illustrated financial evaluation are:

Term of analysis
Energy price escalation factor
Base year savings
Project costs
Additional operation and maintenance costs
Term of financing
Interest rate on financing
Discount rate or minimum acceptable rate of return

A high level of sophistication in financial analysis is not necessary for smaller projects with quick paybacks. Their returns are so assured and rapid that the decision to implement them does not requires a lot of study. However, the financial analysis of any major investment should be tested for its sensitivity to changes in the variables listed above. The following points regarding these variables should be kept in mind when performing or reviewing financial analyses.

**Term.** The term of analysis is usually the economic life of the project. Except for major products, or for new construction, ten years is an adequate period of analysis. Analyses that require long time horizons in order to justify projects involve greater uncertainty.

**Price.** The energy price escalation factor should always be scrutinized closely and confirmed with research on local utility and fuel costs. Escalation factors will vary by energy type, and this should be included in the analysis; the project under consideration should have estimates of energy savings broken out by fuel type.

A straight escalation rate may not accurately reflect expectations in the near term. Be wary of analyses that depend on high, consistent price increases over a long period to show favorable returns. Double check the reasonableness of price escalation assumptions by calculating the effective per unit energy price at the end of the projection period. For example, if electricity costs currently average 5 cents per kwh and are estimated to increase 12 percent per year for ten years, then the price at the end of the projection period is 15.5 cents per kwh. Ask yourself, is this reasonable? If not, then reject and revise the projection.

**Operations & Maintenance.** Operations and maintenance costs of some improvements can be significant. Get an estimate of the savings from your engineering contractor. As a rule of thumb, 5 to 8 percent of original capital costs can be used.

**Financing.** The term and the rate of the financing will affect your cash flow. Longer terms and shorter rates will improve the cash flow more in the beginning period. The term of the financing should not be greater than a conservative estimate of a project's useful life. Most financing options fit easily into the cash flow model above, and most financing arrangements call for level debt service. Variations on this standard must be included in the model. Simply map out the anticipated cash flows.

**Savings.** Actual energy savings from implementing a package of projects may be less than the sum of the individual project estimates of energy savings. For example, consider two improvements—steam line insulation and a boiler conversion—implemented separately and then together. If the boiler is converted to a cheaper fuel, the amount of the energy cost savings will depend on the total energy use times the difference in fuel prices. If the steam lines are insulated, then heat loss and total steam demand will be reduced, thus also reducing the effective savings from the boiler conversion.

**Cost of Delay.** Finally, the speed with which a project is implemented is important. Savings do not begin until the project is complete. Delay means losing potential savings. When comparing financing options, the speed with which financing can be arranged and construction begun should be factored into the NPV analysis.

## Self-Assessment Questions

The following self-assessment questions are divided into three sections. They are intended to prompt your thinking and planning. By answering the first set of questions you will develop the raw material to form an institutional policy for financing energy efficiency. The second set of questions will help you determine which financing options are available to you. The third set will guide you in determining which financing option best meets your institutional needs.

1. What is the process by which capital projects are initiated, screened, compiled, and approved? Who and what offices are involved in the decision making? How long does it take until appropriations are available?

2. Have any energy projects been identified that have not been submitted for funding? What is their estimated cost and savings? Is there a chance that cost-effective projects will not be funded due to limited resources? Has this occurred in the past?

3. What levels of risk—of engineering estimates, equipment performance, energy prices changes—do you want to assume in developing your campus's energy efficiency potential? Are guarantees of energy savings or other arrangements, whereby private firms assume risk, attractive?

4. What is your target rate of return or payback period for energy efficiency investments? Does this rate change with the size of the projects?

5. What is the rate of return achieved by endowment investments? (Include both current yield and appreciation.) What policies govern its use? Are there any restrictions that would disallow use of the endowment for financing campus energy efficiency investments, either by direct investment or as a collateral, if an attractive return on investment can be achieved?

6. What is the "worst case" estimate for future energy price increases in your area? What is a conservative estimate? How much can you expect to be paying for your energy needs, given your current level of efficiency?

7. What dollar resources are available to meet the up-front project costs? Is the immediate positive cash flow criterion for choosing what projects to implement more important than the net present value and return on investment measures?

8. Are there any available building reserve funds? What are the restrictions on their use? What is the nature of the fund—debt service, emergency repair and maintenance? Who administers these monies? Can they be used to finance the "soft costs" of developing energy projects? When is this debt retired? What happens to the revenue and replacement fund on retirement?

9. What in-house engineering, energy conservation, and project management staff resources are available? What types of facilities services and skills are currently subcontracted—electric, HVAC, equipment service contracts, food service?

10. What assets or revenue streams can be offered to secure energy project financing?

11. How are energy costs currently accounted for?

12. What financing options appear to be available and most attractive? What legal institutional barriers exist to their use? What is the institutional procedure by which these options would be utilized? What is the procurement procedure for major projects? For consultants?

## Financing Resources

This section discusses creative approaches to using traditional funding sources for financing energy projects. These financing options are:

Grants
Commercial Bank Borrowing
Endowments
Building Reserve and Replacement Funds
Financing with Tax-Exempt Bonds
Fund Raising
Leasing and Vendor Financing
Performance Contracting
Utility-Sponsored Programs

**Grants.** Have you contacted your state energy office regarding grants under the Federal Institutional Conservation Program?

**Commercial Bank Borrowing.** Do you have a close relationship with any commercial bankers? What loan terms will they offer? Given these terms, what projects can be financed on a positive cash flow basis? Are they interested in purchasing tax-exempt debt? Can they offer interim or short-term financing for energy projects?

**Endowments.** What is the rate of return achieved by the endowment (include both current yield and appreciation)? What policies govern its use? Are there any restrictions that would disallow use of the endowment for financing energy efficiency investments, either by direct investment or as collateral, if an attractive rate of return can be achieved?

**Building Reserve and Replacement Funds.** Are there any available reserve and replacement funds? What are the restrictions on their use? What is the nature of the funds—debt service, emergency repair and maintenance? Who administers the monies? Can they be used to finance the "soft" costs of developing energy projects? When is the debt retired? What happens to the reserve and replacement fund on retirement of the loan or bond?

**Tax-Exempt Bonds.** Do you have an Educational Facilities Authority in your state? If not, is there a municipal or industrial development authority with whom you could work? Is the director of the authority interested in forming a bond fund pool? Are there enough small colleges in your state to assemble the capital requirement necessary to form a pool? Can you identify any private placement purchasers of tax-exempt debt?

**Fund-Raising.** When is your next development campaign? Are energy projects to be included? Would they make attractive projects to raise funds for? Could your stock of potential donors be increased by offering them investment rather than simply soliciting gifts?

**Leasing and Vendor Financing.** Are any of the identified projects leasable equipment? Do the equipment vendors offer any financing? Can they recommend or can you identify other leasing companies? What terms and rates do they offer?

**Performance Contracting.** Do you have significant savings potential, but do not want to take on the costs, risks, and administrative tasks of aggressive energy management? Do you need a lot of outside assistance in training and engineering to achieve efficiency? If so, would you entertain a performance proposal? Can you constructively use this arrangement to your advantage? From a financial perspective, including a realistic estimate of the speed with which you will act on energy projects, how does performance contracting compare to the other options? If you are currently working with an engineering firm, would they be interested in a performance contracting arrangement or some guarantee of energy savings? Can you effectively manage a performance contract?

**Utility-Sponsored Programs.** Utility companies offer both engineering and financial assistance for energy programs. Check with your local utility for detials. For more discussion of these programs, see "Demand-Side Management," pages 118-119.

## Comparing Available Financing Options

1. Which option offers the lowest effective interest rate and the longest terms?
2. With which option is the net present value of net energy cost savings maximized?
3. Which option generates an immediate cash flow improvement? Which option includes the "soft" costs of energy project development in the financing?
4. Which option maximizes the total resources available to your campus? For which option is the financing "off-credit"?
5. Which option is easiest to use?

6. Which option expedites the acquisition of energy equipment?

7. With which option are the risks of energy investment borne by the private firm?

## Summary Outline of a Financing Policy

I. Commit to funding all energy efficiency projects that are cost effective. Cost effectiveness criteria are:

  a) Project meets return on investment (ROI) hurdle rate

  b) Project can be financed on a positive cash flow basis (energy savings greater than the finance payments)

II. Identify the best possible financing options

  Procedure for their use

  Rates and terms

III. Determine campus attitudes toward the risks associated with energy projects and how to manage them. Risks are:

  Future price changes

  Technical

  Engineering

  Equipment performance

  Operations

IV. Establish a target rate of return for energy efficiency investments.

V. Outline the financial analysis procedures you will use for decision-making on energy projects: simple payback, return on investment, net present value, and cash flow improvement.

Initially, the primary sources of financing for energy efficiency improvements were internal funding and federal grants through the U.S. Department of Energy (for further information on these and other programs, contact your state energy office or APPA). However, the government has been phasing out these programs and future funding levels are uncertain. Competition for whatever funds are available is intense, and those funds will be inadequate to support all cost-effective projects. Therefore, reliance solely on internal funds or federal and state grants for energy project financing results in gross underinvestment in energy savings projects . Thus, it is important to identify alternative financing sources to fill this gap and ensure enough capital for your institution to take full advantage of its savings potential.

## Commercial Bank Borrowing

A commercial bank loan is an established, familiar mechanism that can be used to fund all types of energy improvements. When seeking funding for energy improvements, explain the principles of positive cash flow financing.

Bank loans for these purposes are usually for two- to three-year terms, five years at most. Such short terms raise monthly payments and may prevent achieving an immediate positive cash flow.

Bank interest rates are also higher: prime plus 1 to 2 percent, depending on the credit risk. For larger size loan requests, over $200,000, find out if your local banks have an appetite for tax-exempt debt. This will depend on how much taxable income they need to shelter. If they are interested in purchasing tax-exempt debt, a private placement could be arranged.

Because of their higher rates and shorter terms, bank loans will not generally be the best option for major projects. A good use of your local bank relationship for energy financing would be to establish a line of credit, with terms, for funding smaller, rapid payback projects. These projects can be funded as identified, instead of postponing their implementation for packaging in a larger financing. The local bank can issue letters of credit as security, or make short term construction loans in advance of long term financing.

## Endowment

Endowment can be used to finance efficiency investments directly, or it can be used as collateral to secure another type of financing. Better rates of return have been achieved in a high interest rate environment. But significantly higher returns may be achieved by investing in energy efficiency measures rather than in traditional investment instruments.

Only unrestricted endowment can be used. It may be possible to modify restrictions to allow use of funds. Since endowment is meant to be preserved, to yield a stable source of income, accounting arrangements should be made to reimburse the endowment out of energy savings just as if debt service payment were being made. Some endowments are set aside to provide for operating expenses for certain buildings. In such cases, it would be entirely appropriate to use these funds to reduce energy operating costs.

Alternatively, endowment can be used as collateral. Any college that can fully collateralize a new debt will have no security problems when borrowing.

Therefore, the borrowing should be attempted at tax-exempt rates. Through a facilities authority (see Bond section), you can issue tax-exempt debt. Bonds can be issued or, for smaller amounts, a private placement can be arranged. You will continue to receive full market rates of return on escrowed endowment while paying tax-exempt rates on the funds borrowed against it.

## Using Building Reserve and Replacement Funds for Energy Projects

Tax-exempt bonds and federal loans have been major sources of funding for new construction of campus facilities. Under the terms of the bond indentures and federal loan agreements, building reserve and repair funds were established. These funds can be tapped to pay for energy efficiency improvements, or fund the initial cost of auditing and engineering necessary to develop an energy management program.

All tax-exempt bond issues for the construction of new facilities set up at least three funds: a debt service fund, a debt service reserve fund, and a building repair fund. The covenants of each individual bond issue need to be examined to determine the legitimate uses of these funds, but, in general, the building repair fund—also known as the "project reserve fund," "repair and replacement fund," or "building and equipment fund"—exists to make improvements and emergency repairs to the building. Since the security for many bond issues is the revenue generated by the building that the bond proceeds financed, it is in the interests of the bond holders to have this money available to keep the building in good operating condition.

The function of these building repair funds is broadly defined. To quote an official bond statement:

> Moneys in the Project Reserve Fund shall be applied to defray the extraordinary costs of maintaining, repairing, replacing, renovating and improving the Project and its equipment and to the repair and replacement of damaged property of the project; and may be applied subject to Authority [the bond authority] approval for the acquisition of new equipment and improvements and betterments to the Project.

Similar terms govern the use of funds established by government agency educational facilities construction loans.

These funds are usually set equal to 5 percent of the original loan or bond principal. Bond authorities consider building repair funds to be the third line of protection for bond holders and would not likely authorize their expenditure for other than emergency repairs if a college had been delinquent on debt service payments. If the bonds are close to maturity, then the pressure to maintain the full building reserve fund intact is reduced. No apparent restrictions exist to using these funds for energy improvements. Access to these funds can be obtained by the approval of the reserve fund administrators, either the bond authority or the federal agency now handling loan collections. Funds can only be used on the projects (buildings) for which they were established. The funds can be tapped for improvements and also for auditing and engineering costs.

## Tax-Exempt Bond Financing

Tax-exempt bonds (TEBs) have been a common source of capital for the construction of higher education facilities. Interest income from TEBs is tax exempt to the bondholder and, therefore, the bonds carry lower interest rates. The term of bond financing for new construction is normally twenty to thirty years. Bond issues for renovations can have terms from six to ten years and the proceeds can be used for any type of energy efficiency improvement. This combination of lower interest rates, longer terms, and flexibility in use of funds makes TEBs an attractive source of capital for energy projects.

**Identify an Issuing Authority.** The first step to take to use TEB financing is to identify and contact an issuing bond authority. Private colleges can issue tax-exempt debt via state chartered Educational Facilities Authorities (EFAs). EFAs are committed to higher education and are an ideal identifiable vehicle for arranging bond financing of energy improvements. They are there to serve you.

Many states have established EFAs or their equivalent. A college may be able to access TEB financing even if its state does not have an EFA. Contact your state's higher education board or legislature for information.

**Security.** The key component in a bond issue is arranging security. Primary security refers to the principal source of funds for the payment of bond principal and interest. The most general form of security that a campus can offer is "the full faith and credit" of the institution. Specific sources of revenue can be pledged, or targeted, for debt service such as a percentage of tuition revenue or revenues from residence hall operations. The revenue stream need not be directly related to the project being financed. For example, revenues from two existing debt-free dormitories have been used as security for bond financing of academic facilities in Texas. Colleges are beginning to retire debts incurred for original building construction. The assets and revenue streams used to secure these debts will become unencumbered and can be used to secure new debt for capital improvements.

Secondary security are assets or revenue streams used to pay bond debt service if primary payment sources fail. Debt service reserve funds, set up by the original bond indenture, are the first source of funds to be used in this event. For new facilities construction, the title to the facility itself serves as partial security. Unrestricted or quasi-endowment can be used to collateralize the issue. Insurance can be purchased to guarantee bond repayment. Letters of credit backing the issue can be obtained. Purchases of these repayment guarantees can improve an issue's rating but cannot serve as the key factor in making an issue marketable. If the issue is unratable on its own, these insurers will not likely accept the risk of guaranteeing it.

## Bond Issues for Energy Projects

A single bond issue for your campus energy projects is not likely to be feasible because, for more underwriters and issuing authorities, the minimum size of a bond issue is around $2 million, due to the high transaction and administrative costs involved. This amount is larger than most campus's capital requirements for energy projects. If you are using TEB financing for any other purpose, the cost of energy projects can be rolled into the financing. Otherwise, there are two solutions to the problem of accessing tax-exempt financing for energy projects: private placements and bond fund pools.

**Private Placements.** EFAs can economically issue tax-exempt debt for private placement in amounts as low as $200,000. Private placements can be arranged at relatively low transaction costs. Usually no underwriter is involved, only one single bond buyer. The key is finding the purchaser-buyer for the tax-exempt bonds on a private placement basis. For colleges with favorable relations with their local banks or other financial institution, private placements are worth investigating. A buyer may be willing to accept debt from a college that would not qualify for an investment grade rating necessary to sell the bonds in the open market.

**Bond Fund Pools.** A bond fund pool is a means to offer tax-exempt bond financing for numerous smaller projects, by utilizing the proceeds of one single issue. The expense and inconvenience of issuing a bond is minimized by spreading it over many pool members. Bond proceeds would be loaned to individual institutions by the EFA. The borrowing college makes loan payments to a trustee who, in turn, repays the bondholders. The issuing authority has three years to disburse all the bond proceeds according to IRS regulations. The term of the loans can not exceed the remaining term of the bond. The EFA lends at a rate slightly higher than that on the bond issue, the income from the interest spread going to fund the administrative costs of the pool.

**Working Models.** If there is a demand for capital on the part of the colleges and universities, a bond fund pool can be formed.

Loans from the bond pool can be structured so that energy cost savings is greater than loan debt service. With a typical seven-year loan at 7 percent interest, all energy projects with a four-year payback period and less can be financed on a positive cash flow basis. This calculation includes an allowance for project operations and maintenance costs. Longer loan terms will allow longer payback projects to be implemented.

**Security for the Bond Pool.** The key security of bond pool issue lies in the required terms of the loan agreements which the issuing authority enters into with each borrowing institution. The following have been stipulated as loan conditions in hospital bond pool issues. The borrowing institution must meet at least one of the following conditions:

1. Have an investment grade rating from Standard and Poor's or Moody's
2. Be an approved eligible borrower of the insurance company insuring the entire issue
3. Have an irrevocable letter of credit from an approved financial institution
4. Have escrowed certain collateral, cash, or securities
5. Have an insurance policy guaranteeing loan repayment.

Debt reserve funds, established as part of the bond issue, and interest income from arbitrage also provide additional security. There are no cross-default provisions that require some pool members to bear financial responsibility in the event one member defaults. Liabilities of pool members are limited to the amount of their individual loan.

Stronger, more credit-worthy institutions may be able to achieve a lower interest cost by borrowing or issuing their own bonds. Securing the pooled issue involves added cost, either for a large reserve fund or for bond insurance. To fairly allocate the costs of securing the bonds and prevent the stronger credits in the pool from subsidizing the weaker ones, the interest rates on loans for individual institutions can be varied so that they accurately reflect their loan risk. A successful bond fund pool must be properly designed to fairly distribute the risks and costs associated with a pool. The key for a secure and marketable issue is strict lending guidelines with adequate security for each individual loan.

If a letter of credit or other form of secondary security is obtained on each individual loan agreement, then blanket insurance on the entire issue may be redundant and cause additional unnecessary expense. One of the major benefits of the blanket guarantee of debt service is in marketing the bonds. Without the blanket guarantee, credit analysis of the issues becomes more complicated, making the bonds more difficult to sell. Letters of credit providing blanket guarantees of debt service on a whole bond issue (rather than on each individual loan agreement) should be priced as an alternative to insurance, though they will likely be more expensive.

**Organizing.** Bond pools can work for private higher education. It is a matter of organizing and developing adequate security arrangements. Several investment banking firms, commercial banks, and other financial institutions have devoted considerable time to developing pools. State independent college associations have also taken the lead in some states to begin to form pools. We encourage you to contact your EFA if you are interested and have projects to finance.

## Fund Raising for Energy Projects—New Strategies for Development

At first glance, energy efficiency projects do not seem to have the glamour necessary to inspire donations. Newly insulated steam lines or modified HVAC systems are not readily visible contributions. New buildings or advanced research equipment make more attractive projects to contribute to because they provide such tangible benefits. However, an excellent case can be made for donations for energy projects as "the gift that keeps on giving."

Take, for example, a $50,000 donation to implement a project with a three-year payback period. Assuming a 4 percent annual energy price increase, this one-time gift will generate over $175,000 in savings over ten years. The financial benefit resulting from the donation has been multiplied fourfold. And it will continue to generate savings over the economic life of the project. When explained in this manner, energy projects can become attractive to potential donors and an asset to development officers in their fund-raising efforts.

Energy efficiency is sound, responsible management, worthy of outside support. Your fund-raising capacity is a limited resource. Unrestricted gifts are preferred because they can be used where the need is greatest. While you may want to preserve your fund-raising capacity for higher priority purposes than energy conservation, consider this: although a donation for an energy project is a restricted purpose gift, the cost savings accruing from it are effectively general purpose monies, an attractive feature. If necessary to satisfy a donor's special interest, some restriction can be placed on the use of the energy cost savings. It would not be wise to commit all of the cost savings to a restricted purpose because of the subsequent loss of budgeting flexibility.

Energy cost savings can be separately accounted for and, for several years after the donation, a portion of the savings can be deposited in a fund applied to the donor's special interest, be it scholarships, research, or athletic programs. This portion should be calculated to accumulate a sum greater than the original donation. Thus, gifts for energy projects offer a way for donors to leverage their contributions by combining development with financing programs.

As an alternative to soliciting outright gifts, a college can use its development office to market or selectively place financial instruments used to fund energy projects. These financial instruments could be tax-exempt bonds, lease participation certificates (representing a pro rata interest in a lease obligation) or some other vehicle.

The "donation" component of the program can take several forms. The purchasers of the financial instruments may accept lower interest rates, higher risk, or they may donate the instrument back to the institution at some future date or into trust.

1. Investor/donors may accept a lower, below market interest rate on the instruments they purchase. The interest income they sacrifice becomes their donation.

2. Investor/donors may accept a higher degree of risk. This does not mean that the energy project itself can be unsound. Rather, the investor/donor, being sympathetic to the goals of your college and having faith in its administration, will accept less rigid credit standards than would be required to rate a security for sale on the open market. Passing credit worthiness standards can be a major hurdle to acquiring financing.

3. After the financial instruments are sold, the development office can approach the purchasers periodically and request that they be donated back to your college.

4. Another option is to ask the investor/donor to place the instruments into trust, most commonly a charitable remainder unitrust. The donation to a unitrust entitles the donor to a charitable deduction from tax liability equal to the full principal amount of the instruments contributed. The donor also continues to receive the interest income from the securities. For tax-exempt bonds and municipal lease-purchase certificates, the interest income is tax-exempt to the investor. This income plus the charitable tax deduction offsets a significant portion of the donation cost to the donor. The amount of the tax offset is determined by the investor's marginal tax rate, the timing of the trust's creation and the interest rate and term of the instrument. When the instrument matures, interest payments cease and the principal is transferred to your college. If the full amount of the financing is placed into trust, the institution will have acquired the project for the interest costs only. By offering an asset for sale instead of requesting straight donations, the number and income range of people participating in the program can be significantly expanded. More alumni will be in a position to make an investment than a donation and could also contribute a larger amount on these terms. The disadvantage of the program is that it mixes donating with investing. Investment decision making involves different motivations and criteria than gift giving.

## Leasing

A lease is a means to convey the right to use a piece of property without conveying ownership. Thus, leasing is an alternative to the direct ownership of energy saving equipment. The main attraction of leasing is that it allows the use of energy saving equipment without incurring large up-front costs. Monthly lease payments can be of a lesser amount than monthly energy savings, resulting in a positive cash flow from the beginning of the installation.

The lessor maintains ownership of the equipment while it is being used by the lessee. The lessor is able to claim all the tax credits and expense deductions associated with ownership. Current federal tax law does not allow investment tax credits to be taken by the lessor on property leased to a tax-exempt institution, although the lessor is eligible for accelerated depreciation deductions. This reduces the attractiveness of the transaction to the lessor and results in a higher lease rate. However, an important exception to this law is for leases of buildings that have been rehabilitated. Transactions that function similar to a true lease but are written as service contracts may qualify the equipment owner for the investment tax credit. Some performance contracts achieve this credit.

There are two types of leases applicable to the small private college: a true lease and a financing lease. Under a true lease, the lessee cannot specify the terms of the purchase option at other than fair market value. For financial analysis, some estimate of the purchase price at the end of the lease term is made. True leases also carry cancellation clauses.

It can be useful to exercise this clause if energy equipment needs to be upgraded before the end of the lease term or if the equipment is not performing properly. A true lease can only be transacted for property that has economic value and can reasonably be removed and installed at another facility after the lease term. Thus, many energy saving improvements that are more or less permanent fixtures to a building are not eligible to be leased. A financing lease is really an installment or conditional sales contract. Lease payments are set by amortizing the full value of the equipment over the lease term, in contrast to a true lease, which requires the lessor to always maintain a minimum interest in the property, as defined by the current tax law. The purchase option at the end of the financing lease is set at a nominal amount.

The two most common types of lessors are vendors and leasing companies. Vendors of major conservation equipment should be queried as to the financing they offer. Other leasing companies can be identified locally. When shopping for lease financing or reviewing lease proposals, have the vendor/lessor specify the equipment price, the effective lease interest rate, the terms of the buyout and cancellation options, and the lease payment.

## Performance Contract Financing

Dollar savings from institutional energy conservation are so great they have attracted private businesses which, in turn, have begun to address the barriers to energy efficiency investment with "performance" contracting.

A number of private companies now offer to install energy efficiency capital improvements in exchange for receiving, as their compensation, a portion of the energy cost savings that accrue. Typically, such a company enters into a long-term contract and, at its expense, engineers, installs, and manages or co-manages an energy efficiency system for a building.

The most attractive feature of these financing plans is that no up-front costs are incurred by the client energy user. Up-front capital is provided by the private firm, the cost of that capital is spread out over the length of the contract through the service payments. Further, the private firm assumes many of the risks of the success of the installation. An institution is only required to pay a percentage of what it saves. If no savings are realized, no payment is due.

**Description of Performance Contracts.** Three critical services are offered by a performance contract.

1. Engineering
2. Financing
3. Energy system management.

There are two principal types of contractual arrangements: performance and energy services contracts.

**Energy Service Contracts.** An energy service company is a full service company that contracts to provide given levels of heating, cooling, lighting, and equipment use. An energy service company assumes responsibility for utility bill payments and makes its profit on the spread between its cost of providing energy services and its fees. Fees are guaranteed to be a negotiated percentage of what the same level of energy services would have cost if you kept operating at the same level of efficiency. The company makes capital improvements to provide energy services more efficiently, at no expense to you.

**Performance Contract.** Performance contract companies (PCCs) and contracts are more common. A PCC can be used to finance specific energy projects and has most commonly been used for energy control systems. Other types of installations that can be financed by performance contract include: heat recovery systems, cogeneration projects, and boiler conversions. This type of financing, while new, is gaining in frequency and reputation.

The share of savings required by the investor to make the investment economically attractive will vary from 50 percent to as high as 90 percent. In order to more rapidly reduce the performance contract firm's amount of risk, the share of savings accruing to the building owner may be lower during the first year of the contract and higher thereafter. Payments are based solely on actual savings realized. If no savings accrue, then the energy user is not liable to make payments. Performance contracts are being written for terms of five to twelve years.

**Business Procedure.** A performance contract company will generally go through the following business procedures. In general, decision points are reached along the way where greater commitment is required from the energy user. To verify the profitability of potential investment, the performance contract company must independently qualify energy efficiency improvements. Frequently, the company acts as project engineer and takes the lead role in the identification and design of efficiency projects. Or, a company may evaluate and then finance a project already identified by the institution. Performance contracting can be made flexible and responsive to both the energy user and the energy firm's particular requirements. A successful contract will be one that all parties participate in developing.

A performance contract company will conduct a preliminary study to identify your institution's energy savings potential. It will then make its preliminary proposal. The company will be seeking agreement to move to the second stage: performing a thorough energy engineering analysis to develop a complete set of recommendations for improving energy efficiency. To move to this second stage, the company will require the energy user to agree to pay for the energy study, although not necessarily to enter the final contract.

Once the study is made and projects are identified, a single project or a set of projects are selected for execution and a contract is drawn. The company will install, monitor, and maintain the specified equipment until the end of the contract period, at which time the building owner will take ownership of the equipment in the manner described in the contract.

**Contract Provisions.** The performance contract must address several key issues. Here is a checklist of questions to discuss when considering a performance contract agreement.

- *Purchase Option.* At the end of the contract term, how are the improvements disposed of? Can the contract fix a purchase option price? Could the improvements be donated, and, if so, what would be the tax benefits to the investor? Can the contract be bought out prematurely?

  At the end of the contract term, the client usually has three options: renew the contract, buy the installed equipment, or have it removed. The purchase option is usually for fair market value. No other price can be set or else the firm will jeopardize the definition of the arrangement as a service agreement and lose the investment tax credit. Most contracts have "buy out" provisions that can be exercised before the end of the contract period.

- *Calculating Savings.* How are energy savings calculated? This is the most difficult part of a performance contract. Energy cost savings are easy to calculate for some types of improvements, such as a boiler conversion where the savings are simply the difference in fuel prices multiplied by the quantity of energy consumed. Other improvements for which savings are less easily isolated require that a base year be established and used as a reference against which to measure savings. "Base year" consumption will usually represent an average of the last few years, corrected for variations in weather and building use patterns. Special attention must be paid to the establishment of the base year, for it will determine the amount of the performance contract payment. The energy user may want to arrange for, and stipulate in the contract, independent monitoring of energy savings results. Further, a procedure for refiguring the base year should be outlined to accommodate changes in building use patterns, additional conservation improvements, and other contingencies.
- *Schedule of Savings.* What is the schedule for sharing? Is there any upper limit on the amount of savings? Savings are a function of price. If prices increase drastically, so will the savings payments. Remember, the savings schedule is negotiable and should represent an appropriate distribution of the costs and benefits of the energy program.
- *Guarantees.* Is a minimum level of savings guaranteed? Guarantees are based on projected energy unit consumption, not total energy dollar costs which, because they are a function of uncertain prices, cannot be guaranteed by the firm.
- *Operations and Maintenance.* How is the responsibility for equipment operations and maintenance distributed? The private firm generally retains operating and maintenance responsibility for the equipment after it is installed in the user's premises. This allows the firm to claim the full tax benefits of ownership because the equipment remains the business's property. Your current staff can still perform operations and maintenance functions. The firm does not have to assume direct operations and maintenance responsibility but may subcontract the work or simply advise existing facilities staff to assure that the standards on which they based their energy-savings projections are met.

## Advantages and Disadvantages Checklist

### Advantages

1. No upfront costs are required of the institution. An immediate positive cash flow can be generated by the transaction.

2. At the end of the contract term, all the capital improvements revert to the building owner.

3. Guarantees are offered by some firms, assigning to them the risk of technical performance.

4. Management assistance, even training, is provided.

5. The financing is "off-credit."

6. The shared performance contract firm acts as an expert turnkey developer.

**Disadvantages**

1. Underinvestment. Most performance contract companies will not consider implementing energy efficiency improvements that have more than a three-year payback period. Many limit themselves to two- and even one-year payback measures, leaving many cost-effective measures unimplemented. Thus, full reliance on a PCC for energy management could result in underinvestment in energy efficiency and lost potential savings.

2. Management Intervention. A PCC involves substantial intervention in a building's operation and management. The PCC contract must be supervised very carefully and results independently monitored. All contract contingencies need to be anticipated and addressed in the original contract.

3. Capital Cost. The energy user must share a substantial portion of energy savings. Financial analysis of performance contract versus other options should be performed by laying out the cash flows then deriving the NPV of the net savings for each option.

**Making Decisions: When Is Performance Contracting the Way to Go?** For facilities directors who lack both the initial capital and the in-house technical expertise or organizational momentum to implement an energy management program, the use of a PCC is an alternative that should be considered. A PCC is most perfectly and fairly matched with a client who needs or simply wants to buy both management and financial services.

Use of a PCC can be viewed as a transitional energy management strategy. By shifting some responsibility to the PCC for the first few years of a comprehensive energy management program, plant staff can develop additional knowledge about operations, maintenance, and investment procedures for energy efficiency.

A few but growing number of firms are ready to serve the small college market. Each individual firm must be scrutinized carefully for professionalism, personnel, form of business organization, track record, ability to perform over the term of the contract, and the ability to provide on-site services. It is also appropriate to investigate the firm's source of financing for capital improvements, especially if the investment is designed as a tax shelter. A solid working trust must be established with the firm before engaging it. The complexity of the arrangement demands it. While the complexity will prevent many from using PCCs, energy management is a specialized field and warrants specialized assistance. Your consultant engineer may be interested in providing services on a performance basis.

**Financial Evaluation of Performance Contracts.** Under an energy services contract, the client should request an estimate of the capital expenditures the firm will make and what portion of the savings is expected from operations and maintenance versus capital improvements. Financial evaluation should be performed by projecting cash flow savings from the contract and comparing this to the savings resulting by achieving efficiency on your own. Remember, the PCC provides administrative momentum to your energy management program and can expedite the acquisition of energy savings equipment. It also assumes many of the risks involved with energy efficiency investing. These benefits need to be recognized when comparing cash flows.

## CHAPTER 7

# Energy Management Plan

By completing the following sheets, your campus energy management plan will emerge. The plan will consist of a series of projects and resources (capital, equipment, personnel) that have been identified as areas where potential energy savings exist.

It will be a composite of the information developed within the campus by the president, business officer, facilities director, faculty, students, and staff. These sheets will provide an overview of the physical state of the campus. The consolidation of the information that has been collected will be worth the effort it takes to transpose, tabulate, and detail the actions. A plan is born.

## Potential and Resources

A. Cite the potential for energy reduction for your campus. (Refer to the calculations made in Section I worksheets.)

Potential _______ x cost (audit year) ______ = $ _____ campus energy reduction potential.

B. Can the college, with current resources, reach this potential?

☐ Yes ☐ No

C. If no, for the facilities department, list the resources required including capital funds, equipment, personnel, training, etc. Include those items the operating personnel and the plant tour identified. Also include the recommendations of the president and business officer (pages 69-70).

| Capital | Year 1 | Year 2 | Year 3 | Total |
|---|---|---|---|---|
| Equipment | | | | |
| Personnel | | | | |
| Training | | | | |
| Other | | | | |

## Financing

A. Now let's look at capital costs and financing. Below is a list of financial options. Next to each of the options place a feasibility rating of:

1. VF—Very Feasible (can be used)
2. MF—May be feasible (requires further investigation)
3. NF—Not feasible (cannot be used)
4. DK—Do not know

In the next column, provide the reason for rating each option.

| Financing Option | Rating | Reason |
|---|---|---|
| Commercial Bank Borrowing | | |
| Endowments | | |
| Fund Raising | | |
| Tax-Exempt Bonds | | |
| Building Reserve Funds | | |
| Leasing | | |
| Performance Contracts | | |
| Utility-Sponsored Programs | | |
| Grants | | |

B. List all the options that are Very Feasible.

C. What resources (capital, equipment, personnel) would be required to implement the energy efficiency improvements? List them.

D. List the energy efficiency investments that were identified in the capital assessment section of the workbook (see page 53) and based on other assessments (i.e., grading, see page 58).

E. List all the projects that meet the following criteria:

1. Produces a positive cash flow
2. Has a payback of three years or less
3. Meets with your rate of return of (two points above the rate of the endowment)
4. Will enhance the capital assessed value of the campus.

NOTE: You may want to get assistance in developing the lists. An engineer or financial analyst would be appropriate.

| Project | Cost | Non-energy Benefit |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

TOTAL COSTS $__________

Can all of the above projects be financed using a single financing option?

☐ Yes ☐ No

If yes, what is the financing mechanism? ____________________________

Is it one of the options marked VF? Yes ☐ No ☐

If the answers to the last two questions are yes, then try to package the projects into a single energy efficiency improvement package. If no, can the measures be funded by several of the options? ☐ Yes ☐ No

If yes, move to acquire the finances. If no, rethink the priorities of energy savings.

The remaining sheets synthesize all the information and data collected and serve as the plan, but also are a source for a presentation to the president or board of trustees.

## Physical State of the Campus

Campus Facilities and their letter grade assessments (see Section I, pages 52 through 60).

A. ____________________ D. ______________________________

B. ____________________ E. ______________________________

C. ____________________ F. ______________________________

## Energy Consumption Costs

Past ____________________________________________________

Present __________________________________________________

Future (see Section I, page 46) _________________________________

# Components of an Energy Reduction Plan

A. Operations and maintenance (pages 25-28)

| Action | Estimate costs | Consumption/costs estimate BTU |
|---|---|---|
| | | |

B. Building utilization and policy (page 77)

| Building/Action | Cost saving | O&M saving | Energy | Total savings |
|---|---|---|---|---|
| | | | | |

C. Capital Actions (pages 98-100)

| Actions | Buildings | Cost (1,2,3,4) | Cumulative cash flow improvement |
|---|---|---|---|
| | | | |

## Cashflow Improvement Chart

Prepare a chart for each energy efficiency investment measure to be implemented.

Measure: ____________________________________________

| Year | Cost | Savings | Added O&M | Finance costs | Net savings | Cumulative |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## Summary of Results

If the total energy management plan (operations and maintenance, building utilization, consolidation, and energy efficiency improvements) is implemented, your cash flow improvement over the next three years would include

| Year | Cost | Savings | Net improvement | Cumulative |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

List other buildings and campus benefits that are directly affected by the implementation of the energy efficency investments, such as more attractive campus, better climate control, equipment replaced.

# Section III: Implementation

## CHAPTER 8

# ■ The Planning Matrix

The following chart, Worksheet 8, is a method for organizing and setting priorities for the energy plan—assigning dates, responsibilities of personnel, funds, and placing the plan in the context of the campus. List in sequence the projects you wish to undertake, a start and completion date (recognizing that some projects may be ongoing), who is responsible for the action, what it will cost to implement, the financial source (operating budget/option), and what the administrative, faculty, staff, and student response will be.

The highest priority projects should be those that have the greatest reduction potential for the resources expended.

# Worksheet 8: The Planning Matrix

| Project | Priority | Start Date | Completion Date | Responsibility | Anticipated Cash Flow 10 Years |
|---|---|---|---|---|---|
| | | | | | |

| Implementation Cost $000's | Financial Source | Facility, Academic & Management Implications | Expected EUI Savings |
|---|---|---|---|
| | | | |

| Project | Priority | Start Date | Completion Date | Responsibility | Anticipated Cash Flow 10 Years |
|---|---|---|---|---|---|
| | | | | | |

| Implementation Cost $000's | Financial Source | Facility, Academic & Management Implications | Expected EUI Savings |
|---|---|---|---|
| | | | |

| Project | Priority | Start Date | Completion Date | Responsibility | Anticipated Cash Flow 10 Years |
|---|---|---|---|---|---|
| | | | | | |

| Implementation Cost $000's | Financial Source | Facility, Academic & Management Implications | Expected EUI Savings |
|---|---|---|---|
| | | | |

# Was This Workbook Worth Your Time?

**Compare the savings potential you have calculated in the beginning of this workbook and that which you have identified. Using the same formula as in the introduction, compare the actual costs with the savings potential.**

**To assist you indeterming if it is worth your time, take a few more minutes to make a calculation. The calculation will determine the cost/benefit of completing this workbook. You should compare the cost of personnel time required to complete the workbook with the expected energy you will save.**

Estimate the total salaries of the president, business officer, and facilities director.

$ ______________________________

Divide that amount by the number of work days at your institution:

$ ___________________________ = Daily cost

We estimate the total time required to complete the workbook to be five people days: three for colletion of data and two for a plant tour.

What is the total current energy budget for the campus?

$ _______________________________

Now multiply the campus energy bill by .05 (5 percent).

$ ________________________________________ .

Hourly cost of plant personnel is $ ___________________ .

This cost times sixteen hours = $ ___________________ .

Total cost for five days = $______________________ .

**What is the cost ratio of completing this workbook?**

Daily cost of the president, business officer, and facilities director is

$ _______________ . This cost times three days = $ _________________ .

Hourly cost of plant personnel is $ ________________ .

This cost times sixteen hours = $ __________________ .

Total cost for five days = $______________________ .

The ratio of 5 percent of your energy budget to total costs is

________________ : _________________

# Section IV: Resources

## CHAPTER 9

# Improving Energy Use

## Energy Audit and Analysis

The following constitutes general definitions of energy audits and analyses as defined by the National Society of Professional Engineers.

SIMPLE ENERGY AUDITS
Walk-through by a certified energy auditor.

BUILDING OPERATION AUDIT
Walk-through by professional engineer. This type of audit should cost about $.02 per square foot. Generally includes the following:

- Analysis of existing building: walk-through survey to verify general accuracy of owner-furnished architectural, mechanical, and electrical plans, i.e., is HVAC configuration as shown? Is lighting as shown? Building modifications?
- Analysis of utility records: 1) determine that utility billing is in accordance with most favorable rate schedule or charges available to owner—investigate alternative rate strategies, i.e., primary metering, larger fuel oil tanks, etc.; 2) prepare graph or bar chart indicating previous 1 to 2 years consumption—kwh, gals, ccf, etc., utilizing owner's records; and 3) summarize in Btus per square foot for each energy source and total energy used.

FULL AUDIT
Analysis of equipment and operation. On-site survey and study by at least one professional engineer resulting in more detailed report covering operation and maintenance matters only. This type of audit may cost between $.03 and $.05 per gross square foot of full area. Generally includes the following:

- All features for a building operation audit (as stated above).
- Energy consumption model: 1) tabulate typical annual operating (occupancy) schedules as established with owner staff; 2) prepare monthly energy consumption model showing present conditions tabulate data and indicate by graph, bar chart, or energy pie subdivided into estimated classi-

fication of energy usage, lighting, fans, chillers, etc.; and 3) compare owner's historic utility data with energy model.

ENERGY CONSERVATION STUDY
Analysis of building and its systems, operational procedures, and historical operating data with recommendations for changes in operating procedures, modifications to equipment and other building systems with analysis of payback as a result of each, plus estimated cost of implementation for each. Conducted by professional engineering team. Generally includes all features of the full audit, as stated above, and can cost as much as $.10 per square foot.

ENERGY CONSERVATION STUDY FOLLOW-UP
Professional responsibility to insure operation recommendations are understood and followed; serve as owner's representative where building or equipment changes are undertaken; monitor results for period of x years. Engineering Fees for any follow-up services will he negotiated with owner at the completion of the energy conservation study and upon a determination of full extent of services to be performed on each specific project.

## Noncapital Energy Savings Improvements

There are many energy savings measures that can be implemented easily and at little or no cost. The following is a list of recommendations that should be considered as you upgrade the efficiency level of the operating and maintenance procedures on campus. The recommendations are divided into three sections: 1) Scheduling of Building Use, 2) Operating Conditions, and 3) Programmed Maintenance.

I. SCHEDULING OF BUILDING USE

A. Classroom, laboratory, and administrative buildings

1. Activities should not be scheduled in any given building unless at least one half of the building is to be used. Equipment use in the unoccupied sections of the building should always be turned off or reduced (e.g., lighting, HVAC, etc.) whenever possible.

2. During periods of low activity (e.g., summer session, holidays, weekends) activities should be consolidated into fewer buildings or sections of buildings.

3. Never leave any piece of equipment or system running unnecessarily.

B. Dormitories

1. Resident-owned appliances and electronic equipment should be limited in quantity and type in order to meet campus specifications.

2. Conduct an Energy Education Program:

a. Provide instructions to residents on how to operate heating, cooling, and ventilation equipment more efficiently.
b. Encourage residents to voluntarily limit shower length and use of hot water.
c. Appoint a "resident energy manager" for each dormitory.

## II. OPERATING CONDITIONS

### A. Lighting

1. Lights should be turned off whenever a room is unoccupied for more than five minutes.
2. Take full advantage of daylight by keeping drapes and other window shading devices opened during the day during the winter.
3. Locate tasks near windows to capture daylight and thus reduce the level of artificial lighting.
4. Plant deciduous trees near windows to allow for solar gain in the winter and shading for the summer months.
5. Insulating and other types of drapes and shading devices should be drawn at all times when natural light is not being used (e.g., winter evenings so that heat can be retained).
6. Reduce lighting in areas with minimal activity by removing the bulb or tube from every other fixture (e.g., in hallways).
7. Install low wattage fluorescent bulbs whenever possible (e.g., when replacing incandescent fixtures in bathrooms, kitchens, hallways, etc.).
8. Consider task lighting, install fixtures in areas of maximum activity or provide desk lamps.
9. In order to increase the amount of natural light, consider installing reflectors on the exterior of the building with the reflectors directed toward the ceiling.
10. Reduce outdoor lighting in areas of inactivity or lighting designed for purely decorative purposes.

B. Space heating and cooling temperatures should be set to campus standards during periods in which buildings are occupied.

### C. Older Buildings

1. Set back temperatures in unoccupied buildings to about 55°F during the heating season in climates where the temperature falls below 30°F; if the temperature is generally above 30°F, turn the thermostat off.
2. The temperature should be turned up in order to heat the building in the morning for its first occupants and then should be set back (coasting) during the last two hours of the work/academic day.

### D. Newer Buildings

1. During unoccupied periods of eight hours or more, the building temperature should be set back unless the outside temperature falls below 30°F.
2. During the cold winter months, the heating system should be placed at the setting for normal work/academic heating levels one hour before building is to be occupied. During other times, the temperature should be set at the time the work/academic day actually begins.
3. The heating system should be set at the "coasting" level during the last hour of the work/academic day.

### E. Physical Education Facilities

1. Outside air systems should be shut down when the physical education facility is not in use.

2. Turn on only those banks of lighting required for the scheduled activities.

3. Doors leading out of the building should always be kept closed.

F. Boilers

1. Boilers should be operated only during periods when heating is actually required (e.g., when classes are in session, etc.). This can be modified by the need to operate boilers for 24 hours a day for longer unit life.

G. Ventilation

1. Ventilation and air-handling systems fans should not be operated during periods when the building is unoccupied.

III. PROGRAMMED MAINTENANCE

A. Building Enclosure Shell (nonenergized system)

1. Install caulking around windows, cracks in the building wall, and around pipes that lead into and out of the building structure.

2. Install weatherstripping around doors and windows.

3. Windows and doors should fit tightly. Make sure that window gaskets and door closures are in good condition.

4. Check the current condition and level of insulation in buildings. Install additional insulation in ceilings, floors, and wall areas.

5. Consider installing storm windows and doors or double-glazed glass.

B. Boilers

1. Maintenance and operations manuals for heating plant equipment should be easily accessible at all times (maintain in facilities department library). Manual's operating instructions should be understood by all appropriate facilities personnel.

2. Establish and carry out a quarterly and annual schedule to ensure the efficient operation of the boiler system.

3. For all large boiler (over 2,000 MBtu input rating) burners a flue gas analysis should be performed, as well as all adjustments required for efficient operation.

4. All boiler burners should be inspected on a regular basis and the proper adjustments made whenever required.

5. The condition of the heating plant controls should be checked on a regular basis to ensure proper operation—all facilities personnel should understand how to operate this equipment.

C. Cooling Plants

1. Maintenance checks should be performed on a quarterly and annual basis.

2. Chillers should not be operated (may be automatically controlled) whenever the outside temperature drops below 55°F.

3. Multiple compressors should be staged to turn on at different times.

4. Check that the reheat systems have been disconnected and that the air supply temperatures have been adjusted accordingly.

5. The condition of the cooling plant controls should be checked regularly and make sure that plant personnel understand how to operate the equipment properly.

D. Distribution System

1. Regularly check all distribution piping for damaged insulation and leakage.
2. All circulation pumps should be checked regularly. Worn parts and connectors should be replaced immediately.

E. Ventilation and Air-Handling Systems

1. Fans should not be operated during unoccupied periods.
2. Fan motors and belts should have regular maintenance checks.
3. Air dampers should fit tightly and activators should be checked regularly.
4. Air-systems controls should be checked regularly. Plant personnel should understand the proper operation of the systems.
5. The exhaust fan operation should be properly coordinated.
6. All filters should be changed or serviced at the recommended intervals.

F. Heating and Cooling Space Temperatures

1. Thermostats should be checked regularly to ensure that they are functional and properly calibrated.
2. Pneumatic control lines should always be kept clean, clear, and dry.
3. Electric controls and wiring should be maintained in good condition.
4. All controls and connectors should be inspected regularly for condition and performance.

G. Lighting Systems

1. Keep all lighting fixtures clean and replace individual bulbs or tubes whenever lighting levels begin to drop.

H. Domestic Hot Water Systems

1. Water temperatures should be reset to 110°F except for kitchen use.
2. Hot water systems should be turned off during lengthy periods when not in use.
3. The distribution piping should be checked regularly for damaged insulation and leakage.
4. Showers should be equipped with flow-restricting heads.
5. If hot water storage tank is separate, add insulation.
6. Install a timer on the circulating pump.
7. Check the hot water system (and its components) on a regular basis to ensure that it is operating properly and efficiently.
8. Consider installing flow aerators on faucets and repair all faucet and other leaks immediately.

## Selecting Energy Efficient Equipment

The rapid proliferation of energy efficiency devices in recent years has increased the importance of selecting appropriate and reliable equipment. It is important not only to avoid unreputable companies and their products, but also to select a good product that works in a specific situation, that can be maintained economically, and that does not cause further problems. While products range from the simple to the extremely complex, the buyer is reminded that one cannot get something for nothing and that energy products often perform in inverse relationship to their publicity. The purpose of this section is to help the buyer get not only a reliable product but one that is suited to the campus's needs.

If you are interested in a particular type of equipment or product, there are a number of steps you can take to investigate the product.

1. If you have such a relationship, contact your engineer or architect for information about the product.

2. Contact the state or national association that represents the equipment manufacturers and installers. These organizations will provide lists of the companies who produce and service specific types of equipment. Many of these associations are concerned with "fly-by-night" producers and installers. Although few in number, such companies have had a negative impact on the industry.

3. If the product is relatively new in the marketplace, request additional information other than sales literature. For example, ask for recent test results regarding the product's performance, typical maintenance expenses, energy saving data, and whether the product has been used. Also ask for justification of claims about savings and for the basis of the claims (experience, estimate, wild guess).

4. If the product has been in the marketplace for some time, request the names of other building operators in your local area (e.g., other colleges and universities or commercial building operators) with similar needs that have installed this particular piece of equipment. Contact several of these building operators to determine the level of satisfaction or types of problems encountered.

5. Contact the local utility providing the kind of energy saved by the equipment to see if they have had adverse or positive experience with the product.

6. From the contractor offering the product, determine if it has any effects on other systems which may be detrimental or which may reduce actual savings. Also, determine if the application envisioned is appropriate for the product. If in doubt, ask for more information or contact an engineer.

7. Carefully check and compare the manufacturer's warrantees and servicing provisions for every product you are considering purchasing.

8. Ask the sales representative if the manufacturer offers a training program for the operation and maintenance of the equipment for your staff. Make sure that you receive an operator's manual with any piece of equipment purchased and a contact who is qualified (by the manufacturer) to answer any additional questions you may have during the life of the product.

9. If the product requires setting or programming, determine if the contractor provides the settings and programming and if this service is included in the price. If the contractor does not, will he or she train your staff to set the system? If not, how much will it cost to have a consultant do it (and revise it each time you wish to make a schedule change)?

# How to Select an Energy Contractor or Consultant

**Identification of Needs.** Upon completion of your self-assessment analyses, you will have more accurate and specific information about the types of improvements required to upgrade the efficiency of your campus. You need to determine what tasks, if any, can be accomplished by your in-house staff. The remaining improvements and associated operations and maintenance tasks will require the services of one or more experienced energy professionals. However, prior to hiring energy professionals, you need to make decisions on the following items:

- Is an energy audit necessary if an audit has already been conducted? Should the existing one be updated or should a more thorough and sophisticated audit be performed?
- What is the scope of the work desired from the contractor? This is especially important if the contract is to include the construction or modification of the facilities.
- Should a "feasibility study" be conducted to select the most appropriate capital investment and other improvements, in terms of 1) potential energy savings, 2) installation and O&M costs, and 3) a ranking process for selection of items for priority action?
- What responsibilities does the contractor have beyond design and/or installation of an energy efficiency improvement? Does she or he have to train campus staff in operating and maintaining the system, does she or he have to provide for full shake-down of the system, including initial settings, full maintenance of the system under contract? Many modern systems are very complex and may well be beyond the capabilities of a small college staff.

**Selection Process.** If you decide that you require the services of outside professionals, consider seeking competitive bids. In recent years, the application of energy saving techniques has become a specialized field. If you have a sufficiently large project or group of projects, competitive bidding will offer you the opportunity to evaluate the qualifications and experience of firms other than those with which you are currently familiar. If you feel that you can obtain sufficient responsible bids to undertake this procedure, you may need to hire a design professional to help you write the specifications for the bidding.

There are a number of questions that need to be answered before beginning the competitive bid process, including determining what scope of work is required of the bidders, whether there will be two steps (preliminary and final design) to the process, and deciding on the selective criteria and the method of reimbursement.

Unfortunately, most small colleges will not be in a position to benefit from the competitive process, because the size of their projects is too small. If you cannot competitively bid out projects, you will have to select a small group of firms and negotiate the best services you can obtain. At a minimum, a firm or contractor should be using products that are recognized by a major trade group, should provide references from other projects, should show financial responsibility, and should have qualified and/or licensed personnel performing all work. Be sure to identify the person in the firm who will be your primary contact.

Local and state associations representing general contractors and architectural and engineering professionals can supply you with the names and address of firms in these fields. Contractor associations represent most contractor specialties and can provide similar information. If you are competitively bidding, you should consider publishing your request for proposals (RFP) in local professional journals and newsletters.

**Project Specifications.** Whether you negotiate with only a few firms or seek competitive bids, you need to supply the following information:

- Deadline date for submission of proposals
- Description of the project's scope of work
- Project schedule
- Required professional qualifications
- References (credit and current and previous clients)
- Process for payment of services

You may have a project that requires highly specialized (energy) needs. For example, you may have a research laboratory or computer center that is energy intensive but has the potential for significant energy use reductions. If this is the case, you may want to limit the submission of proposals to firms with previous experience with facilities of this kind.

**Proposal Review Process.** Establish a review committee to evaluate the proposals. The review committee should be composed of representatives such as the facilities director, the business officer, technical staff, a faculty member with technical expertise, a local banker, etc. The committee should, through process of elimination, select approximately three to five proposals for follow-up interviews. These proposals should be selected on the basis of how well they respond to the specific criteria. You should conduct a background check on the remaining firms by contacting their credit and client references and checking staff credentials. The proposals should then be ranked according to this information, the project cost bid, timetable for completing the work, and so forth.

**Contract Negotiation.** Once you have selected your first choice, you should begin to negotiate the terms of the contract as soon as possible. Should contract negotiations be unsuccessful, begin negotiations immediately with the second-ranked firm or other finalists until agreement is reached. (All other firms should be notified by letter that they were not selected.) If an energy service company is selected to perform work, see pages 98-99 in the financing chapter for additional questions that are specific to this industry.

## Demand-Side Management

Demand-side management (DSM) is a utility industry effort promoted by the state utility commission or corporate commission to require load management on a system-wide basis. In the early 1980s, the trend in the utility industry was to build or begin the review process to get state approval to build more power production facilities. The end result of either of these proposals was the utilities' need to raise rates. The state regulatory agencies' initial response to increased rates was to urge utilities to get their current rate base under control and then come back for the increase. Demand-side management was born.

DSM has become the fuel for the most recent flurry of activities relating to energy management. It can provide funds and engineering assistance to boost an existing energy management effort or serve to get the program off the ground. Incentives are offered to the participant based on kilowatt hour reductions, or specific amounts are set for retrofits or replacements (i.e., $1.75 per energy efficient light bulb purchased and placed in service).

Lighting retrofits have become the focus of the rebate programs because they can produce the quickest impact and the savings calculations are straightforward. However, efforts to expand the lighting retrofits required more expansive program development to enhance the utilities ability to get rate base control. With this development, lease cost planning evolved and both natural gas and electric utilities became active in demand-side management, where before it was principally an electric utility effort.

Taking advantage of your local utilities' voluntary demand-side management program will begin when you contact your local utility representative and initiate your institution's interest in taking advantage of the program(s) they offer. Dust off your old energy audits, dig out your old energy management proposals, then cut and paste your "wish lists." Arrange a meeting with your utility to discuss ways you can work together to breath new life into your energy management efforts.

Remember, every utility wants to "control" its energy profile. That means it is not always in your utilities' best interest to only reduce your consumption. They may want to influence the load factor or period of the day you consume. Before approaching the utility, study the percent utilization of their system. Know whether they will be receptive to load reduction or load sharing. This will determine the type of project support you can expect and assist you in assembling a portfolio that will receive the appropriate attention.

Implementation of demand-side management is a simple process. The institution will file a report on the utility-provided forms (or other accepted format) for consideration. The utility will review the application and provide the applicable funding for qualified measures. Some utilities require ongoing monitoring to verify savings.

# Campus Energy Awareness

In addition to proper building utilization, efficient energy management practices, and the installation of energy efficient materials and equipment, the campus community—administrative staff, faculty, and students—can contribute to your institution's energy conservation program. However, their participation cannot be enlisted until a coordinated effort has been initiated to educate them about what their role can be—in the offices, classroom, and dormitories. The following worksheet collects data from the previous chapters and tailors it to specific characteristics of your college. You can use the resulting information in speeches, announcements, posters, campus newspaper articles, or a general brochure to the campus community.

## What Does Energy Really Cost the School?

1. The energy budget (gas, oil, coal, electricity, etc.) for the current fiscal year:
$ ________________

2. The average faculty salary (you may use the salary of an assistant professor, 3rd year) is: $ __________________

3. The college's energy bill represents ______________ faculty positions.
(divide #1 by #2 = Faculty Positions)

4. The budget of the library, including personnel and acquisitions is:

$ ________________________

5. The ratio of library budget to the energy budget is:

(divide #1 by #4) ______ : ______

6. Total funds the college provides directly for scholarships:

$ __________________________

7. The ratio of scholarship aid to energy is: (divide #1 by #6)

______ : ______

8. The amount the college spends on student services is: $ _________________

9. The ratio of the student services budget to the energy budget is:

(divide #1 by #8) ______ : _______

10. The amount the college spends on research is:

$ ________________

11. The ratio of research to energy is: (divide #1 by #10) ________ : ________

12. A) The amount the college spends on maintenance is: $ ________________

B) The amount the college spends on equipment renewal is:
$ ________________

13. The ratio of maintenance and equipment renewal to energy is:

Maintenance: (divide #1 by #12a) ______ : ______

Equipment renewal: (divide #1 by #12b) ______ : ______

If the campus could save 5, 10, or 15 percent of its energy budget, how might it be allocated?

5% = (#1 x .05) $ ________

10% = (#1x.1) $ ________

15% = (#1 x.15) $ ________

| | 5% Savings | 10% Savings | 15% Savings |
|---|---|---|---|
| Strengthen academic programs | | | |
| Student services | | | |
| Campus maintenance | | | |
| Equipment renewal | | | |
| Other | | | |

The following can be used to develop a brochure in a question and answer format for general campus distribution, part of the freshman package, faculty orientation, or news articles in the campus or local press.

## Did You Know That...

1. Last year the college spent $ ____________ on energy, and this year will spend $ ______________ on energy.

2. That means that we spent $ ____________ per student on energy, or $ _______ per faculty member. Counting students, staff, and faculty, the college spends $ ____________ per member of the academic community.

3. The amount we spend on energy is equal to ____________ faculty positions or ____________ books for the library, or ____________ support personnel, or ____________ teaching assistants, or ____________ student jobs.

4. The campus every year uses ____________ kwh of electricity. That's as much as used by ____________ homes a year. (Get figure from local utility.)

5. The campus burns ________ tons of coal, hundred cubic feet of gas, or gallons of oil a year.

6. Every classroom consumes the equivalent of ____ tons of coal, _______ hundred cubic feet of gas, _______ gallons of oil a year. (Multiply the Btus per square foot, and divide by fuel Btu value)

7. For every tuition dollar, ____ cents goes to energy.

8. It takes ______ men and women to produce, distribute, and maintain the energy systems of the campus.

9. Last year the college distributed $ ___________ for scholarships and spent $ ____________ for energy.

10. Since [base year], the college has saved a total of $ _________ through its energy management efforts.

11. Among the things the college has done to achieve this savings are:

12. Energy savings activities planned for this year are:

13. The goal for the college is to reduce energy by _____ percent, or by $ __________.

***USE ENERGY WISELY—EVERY DOLLAR SPENT ON ENERGY IS ONE LESS DOLLAR SPENT ON YOUR EDUCATION.***

## You and Campus Energy Use

Everyone on campus, including the president, faculty, staff, and students, consume energy. Thus it is everyone's responsibility to use it appropriately. Wasting energy is wasting dollars that can be far better spent elsewhere. Use it, but use it well.

Saving energy does not mean being cold (or hot) in the dark. If your office or room is uncomfortable, it may be a malfunction in the heating or cooling system, *which may actually be using more energy.* So report problems to the facilities department, phone ________________.

If you see malfunctioning equipment, or a water leak, or a light on the fritz, report it! The facilities (buildings and grounds) department has ________ employees for________ square feet of space. Don't assume it's been reported. Take responsibility.

Any and all ideas on energy are welcome. The campus has an energy task force or committee, and many buildings have energy coordinators. If you have a question or suggestion, feel free to contact any of those listed below.

Lighting consumes about ________ percent of the campus total electric bill and about ________ percent of the total energy bill. It is the one form of energy use that you have the most control over. If you need it, use it. If you don't, turn it off.

Comfort is determined by many things, including the clothes you wear. Our bodies lose most of their heat through the head, neck, and ankles. In winter, turtlenecks and wool socks definitely keep you warmer. In summer, open necks are best. (Do men need to wear ties in summer—and is the air conditioning set for closed or open neck wear?)

If you feel that because you've paid tuition or work for the campus you are entitled to use energy—you're right. You're just not entitled to waste it!

# ■ Glossary of Terms

## Technical Terms

BALLAST: A device used for starting fluorescent and high intensity discharge lamps.

BRITISH THERMAL UNIT (Btu): Standard measurement for the quantity of heat required to raise one pound of water by one degree Fahrenheit or the equivalent amount of energy generated by burning a kitchen match.

BUILDING ENERGY FLOW: The process by which passive (natural) and active (utility generated) systems transfer energy into and out of a building.

BUILDING ENVELOPE. The exterior surfaces of a building, such as the roof, walls, windows, doors, etc., that are exposed to climatic conditions.

CONTROL: Any manual or automatic device designed to regulate the operation of a system or system component.

COOLING LOADS: The energy required to achieve the desired (space cooling) temperature level.

CASCADING ENERGY: A process in which waste heat can be used to perform additional functions, at a lower temperature.

CCF: Hundred cubic feet.

CONDUCTION: The transmission of heat through solid matter due to a temperature gradient.

CFM: Cubic feet per minute.

DAMPER: A valve or movable plate that is attached to a duct in order to regulate the flow of air or other gasses.

DEGREE-DAYS (COOLING): The difference between the average temperature of any given day and a base temperature when the median temperature of the given day is higher than the base temperature.

DEGREE-DAYS (HEATING): The difference between the average temperature on any given day and a base temperature when the median temperature of the given day is less than the base temperature. Often the base temperature selected is 65°F.

DEHUMIDIFICATION: The process of removing moisture.

DEMAND: The rate of use of a commodity, often the peak rate during a given period.

DEW POINT TEMPERATURE: The temperature level in which the moisture in the air begins to condense.

DOUBLE (OR DUAL) DUCT SYSTEM: A set of parallel ducts that distribute air that has been "conditioned" in a central component or apparatus into a given space.

DOMESTIC HOT WATER SYSTEM (DHW): A system designed to provide hot water for domestic needs—the energy required for a DHW system will vary according to building size, design, and human needs.

DRY BULB TEMPERATURE: The temperature level as measured on a standard thermometer.

DUCT WORK: A series of piping in which air is transferred from its source to the space that is to be conditioned. Ducts, which should be insulated to improve their efficiency, are generally made from fiberglass or galvanized metal.

ECONOMIZER CYCLE: Use of outside air without further mechanical cooling for space cooling when conditions are appropriate. Typically, this is accomplished by locking out the cooling coil.

EFFICIENCY FACTOR: The ratio of the output of energy versus the input of energy.

ENERGY AUDIT: The collection and evaluation of past and current energy data (consumption, price) and its relationship to the present condition of the building materials and equipment in order to select the most appropriate energy saving measures which will improve the efficiency of a building or system.

ENERGY MANAGEMENT SYSTEM: A full or partially computerized system designed to monitor and control energy use in order to achieve optimal efficiency.

ENERGY USE INDEX (EUI): Annual Btu/Square Foot energy use. The standard index used in most analyses to measure all fuel and energy used in a given building or group of buildings.

FLUORESCENT: Generally tubular in shape, this is a low pressure electric discharge lamp, containing a phosphor coating that transforms some of its ultraviolet energy into light.

FOOT CANDLE: Unit of illumination; the amount of light from one candle that is reflected on one square foot of surface area, one foot in distance from the candle.

HEAT PUMP: A type of heating and cooling system that extracts heat from outside air to heat interior space or can perform in the reverse to cool interior spaces. There are other types of heat pumps, such as water-to-air heat pumps.

HEATING LOADS: Total rate of heat loss from a building under given conditions, often measured in Btus/Hour/Degrees Fahrenheit.

HIGH INTENSITY DISCHARGE LAMPS (HID): General classification for a group of lamps consisting of metal halide, mercury vapor, and high and low pressure sodium. These lamps are most often found outdoors or in high-ceiling locations.

HIGH PRESSURE SODIUM LAMPS: The most efficient of the HID classifications, generally used outdoors giving off a golden-white light.

INCANDESCENT LAMPS: Produces light when an electric current heats the filament contained in the incandescent bulb.

INFILTRATION: As a result of natural forces (wind, temperature differentials), outside air is transferred into a building through openings and cracks in exterior walls, windows, doors, etc.

INSOLATION: Total amount of solar energy (radiation) that is reflected on a given surface which is exposed to the sky.

INSULATION: Use of a material with low conduction to retard the flow of heat the level of effectiveness is determined by the material's thermal properties and its thickness.

KILOWATT HOUR (KWH): A standard unit of energy equivalent to a demand rate of 1000 watts in one hour.

LOAD LEVELING: A process in which the energy demand can be temporarily reduced during certain periods. Typical examples include the intermittent operation of certain electrical equipment, the shutting off of equipment when rooms or buildings are not in use, etc.

LOW PRESSURE SODIUM LAMPS: An efficient HID lamp that has a poor color rendition. Used primarily for outdoor lighting or in security areas of buildings.

MCF: Thousand cubic feet.

MERCURY LAMPS: Mercury vapor lamps of the HID classification, are generally used in public interior spaces and offer the largest variety of HID lamps.

METAL HALIDE LAMPS: Similar in appearance and design to the mercury vapor lamps but, due to the metal halide's inner lamp tube, its color rendition, efficiency and output is favored over the mercury lamp.

MULTIZONE SYSTEM: A system that "controls" the energized equipment in more than one zoned space, by mixing hot and cold air streams at the source and distributing the air through a single duct for each zone.

PASSIVE SOLAR SYSTEM: A typically non-mechanical system that uses solar gain on a building.

PEAK LOAD: The maximum anticipated demand for any given system.

RADIATION: The process in which radiant energy is emitted in the form of waves or particles.

RECOVERABLE WASTE HEAT: The amount of waste heat that can be reused.

RELATIVE HUMIDITY (RH): The percentage of moisture contained in the air compared to saturation.

RETROFIT: Energy saving improvements to a building structure or any of its energized systems involving modification of that structure or system.

R-VALUE: The capacity of a material to retard heat flow. The greater the R-value, the slower the heat flow.

SINGLE ZONE SYSTEM: An HVAC system providing treated air under the control of a single zone thermostat.

SPACE LOAD: The heating, cooling and electrical loads generated within a space or a zone and not including loads of the building shell or air system.

TASK LIGHTING: Lighting (classification, wattage and placement) based on functional tasks to be performed in a given area for optimal energy efficiency without sacrificing eye comfort.

THERM: Equals 100,000 Btus.

TONS OF REFRIGERATION: A standard for identifying cooling capacity. One ton of refrigeration is equal to 12,000 Btu/ hour of cooling.

U-VALUE: The rate of heat loss through a material. The lower the U-value, the less heat is transferred out of a building.

VAPOR BARRIER: Material placed in the exterior wall to prevent moisture-laden air from condensing.

VARIABLE AIR VOLUME (VAV): An HVAC system in which space treatment is provided by a varying quantity of constant temperature air.

VENTILATION: The intentional circulation of air into a given area for comfort and health.

WASTE HEAT: Heat that may or may not be reusable in another process.

WATT: A unit of electrical power.

## Financial Terms

CONSTANT DOLLARS: Monetary value based on the purchasing power within the base year—inflationary impacts are not reflected in the value of the constant dollars.

COST AVOIDANCE: In regard to energy efficiency—the implementation of energy saving measures will result in a dollar savings which will offset any fuel price increase.

ENERGY COST LIABILITY: Estimated future energy expenditures without energy saving improvements.

LIFE CYCLE COSTING (LCC): The analytical process for estimating the total cost of a product or system over the life of the product or system, including the operational and maintenance costs.

NET PRESENT VALUE (NPV): The value of future energy savings—less all project construction and operating costs, discounted to present value.

RETURN ON INVESTMENT (ROI): The discount rate which, when used to discount all present and future project costs and savings, brings the NPV to zero.

# Blank Forms

## About These Blank Forms

This section contains blank versions of the forms that appeared in the exercises throughout this workbook. Please copy these forms as you need them when preparing your own campus energy management plan. Below is a list of forms and the page numbers on which instructions appear.

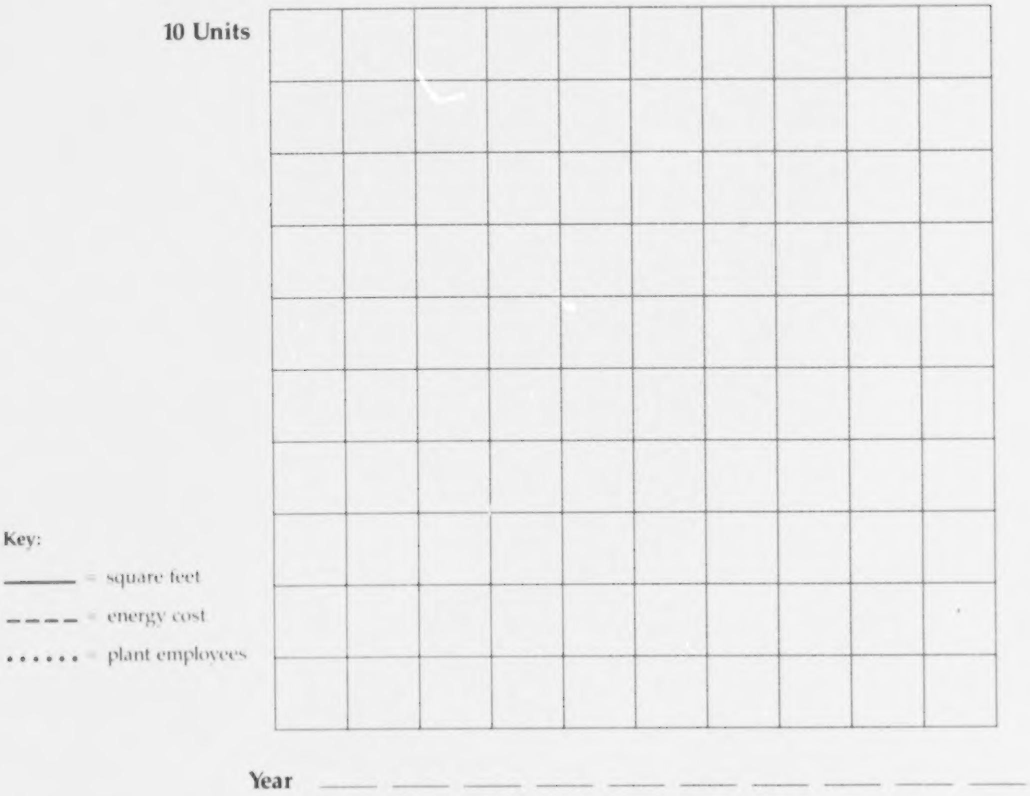
| | |
|---|---|
| Chart 1: Facilities Department History | 25-26 |
| Chart 2: Energy Costs History | 27-28 |
| Table 1: Fuel Type Conversion Table | 34 |
| Worksheet 1A: Fuel Costs | 34-38 |
| Worksheet 1B: Total Campus Energy Indices (EUI) | 34-38 |
| Worksheet 1C: Total Campus Energy Indices (per gross square foot) | 34-38 |
| Worksheet 2A: Weather-Adjusted EUI | 39-45 |
| Worksheet 2B: EUI/Guideline | 39-45 |
| Worksheet 3: Projected Future Energy Use | 46-48 |
| Worksheet 4A: Cost Calculations | 49-51 |
| Worksheet 4B: Cost Calculations Chart | 49-51 |
| Worksheet 5A: Condition Evaluation | 52-57 |
| Worksheet 5B: Building Grade Point Rankings | 58-60 |
| Worksheet 6: Noncapital Energy Savings Improvements | 78 |
| Worksheet 7: Components of an Energy Reduction Plan | 101 |
| Worksheet 8: Planning Matrix | 106 |

## Chart 1: Facilities Department History

For each year below, insert the campus square footage, total annual campus energy costs, and the number of employees in the plant department. (A"typical" scenario is one of increasing square footage, increasing energy costs, and decreasing personnel.)

| Year | A. Square Feet | B. Energy Cost | C. Plant Employees |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

To graph you need:
A. gross square footage B. total energy bill C. total plant employees



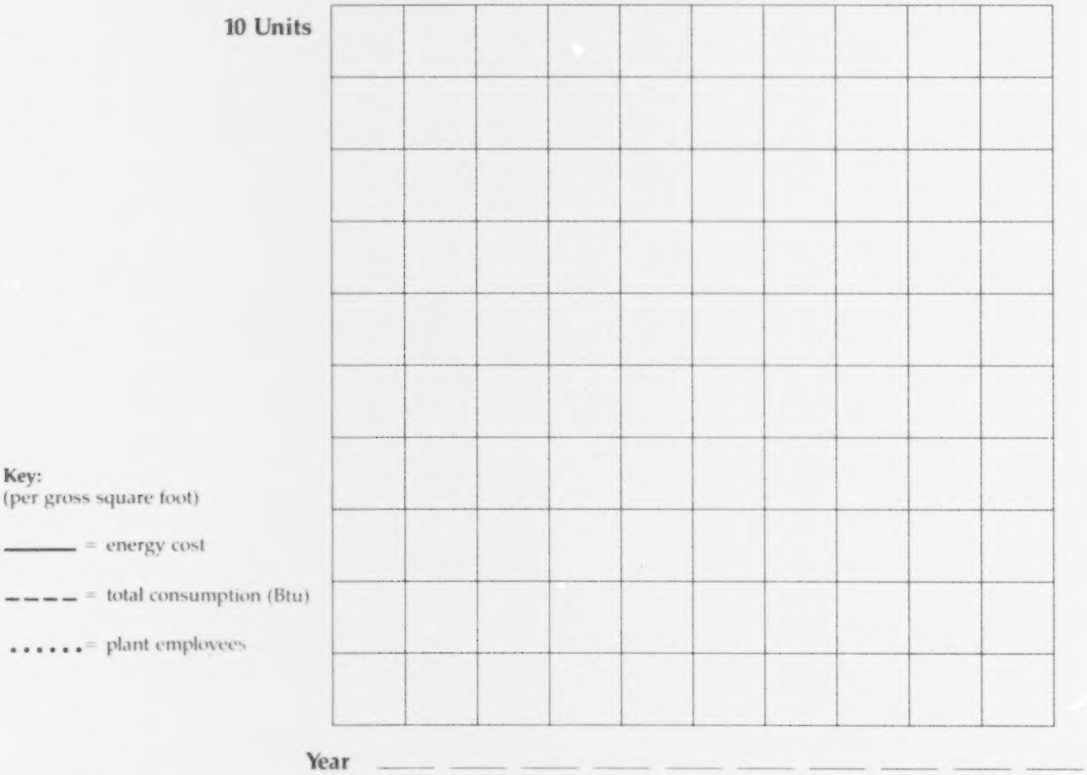
# Chart 2: Energy Costs History

For each of the same years used in Chart 1, show the energy costs per square foot, energy use per square foot, and the number of employees per square foot. This should further illustrate how personnel costs were constrained in order to cover the utility bills.

| | A. | B. | C. |
|---|---|---|---|
| Year | Energy Cost/Sq. Ft. | Btu/Sq. Ft. | Plant Employees/Sq. Ft. |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

To calculate you need:

1. energy cost per square foot = Total energy bill ÷ gross square feet ______
2. energy use per square foot = Total consumption (Btu) ÷ gross square feet ______
3. employees per square foot = Total plant employees ÷ gross square feet ______



# Table 1: Fuel Type Conversion Table

Check the boxes on the Fuel Type Conversion Table 1 below that indicate the types and units of purchase for the fuels used on your campus. Check as many items as apply. The table also tells you the typical energy content of the fuel units purchased in British Thermal Units or Btus. This conversion will be used in Worksheet 1A.

**Table 1—Fuel Type Conversion Table**

| Fuel Type | Check Boxes | Units | Energy Content Equivalent (Btu) |
|---|---|---|---|
| Electricity | ☐ | kwh | 3,410 |
| Natural Gas | ☐ | therm | 100,000 |
|  | ☐ | ccf | 103,000 |
|  | ☐ | mcf | 1,030,000 |
| Propane or lpg | ☐ | ccf | 250,000 |
| #2 Fuel oil | ☐ | gallon | 139,000 |
| #4 Fuel oil | ☐ | gallon | 145,000 |
| #6 Fuel oil | ☐ | gallon | 150,000 |
| Soft coal | ☐ | short ton | 25,000,000 |
| Hard coal | ☐ | short ton | 28,400,000 |
| Steam | ☐ | mlbs | 1,000,000 |

*Note: Energy content figures have been rounded off to three significant digits.

NOTE: In completing Worksheet 1A, one worksheet for each fuel type should be filled out; make one copy of Worksheet 1A for each box checked in the Fuel Type column on the conversion table above. On each copy fill in a fuel type, and assign the fuel a code number: 1, 2, 3, 4,.. etc.

# Worksheet 1A: Fuel Costs

**Fuel Type:** ______________________

**Energy Content** ______________________ **Fuel Code No.:** ______________________ **Units** ______________

| Year* | 1. Fuel Bill Dollars | 2. Physical Units Consumed | × | 3. Btus per Unit | = | 4. Btus Consumed | 5. Gross Sq. Ft. | 6. EUI Btus/Sq. Ft. | 7. Dollars per Sq. Ft. |
|---|---|---|---|---|---|---|---|---|---|
| ____ | ________ | ________ | × | ________ | = | ________ | ________ | ________ | ________ |
| ____ | ________ | ________ | × | ________ | = | ________ | ________ | ________ | ________ |
| ____ | ________ | ________ | × | ________ | = | ________ | ________ | ________ | ________ |
| ____ | ________ | ________ | × | ________ | = | ________ | ________ | ________ | ________ |
| ____ | ________ | ________ | × | ________ | = | ________ | ________ | ________ | ________ |

**Fuel Type:** ______________________

**Energy Content** ______________________ **Fuel Code No.:** ______________________ **Units** ______________

| Year* | 1. Fuel Bill Dollars | 2. Physical Units Consumed | × | 3. Btus per Unit | = | 4. Btus Consumed | 5. Gross Sq. Ft. | 6. EUI Btus/Sq. Ft. | 7. Dollars per Sq. Ft. |
|---|---|---|---|---|---|---|---|---|---|
| ____ | ________ | ________ | × | ________ | = | ________ | ________ | ________ | ________ |
| ____ | ________ | ________ | × | ________ | = | ________ | ________ | ________ | ________ |
| ____ | ________ | ________ | × | ________ | = | ________ | ________ | ________ | ________ |
| ____ | ________ | ________ | × | ________ | = | ________ | ________ | ________ | ________ |
| ____ | ________ | ________ | × | ________ | = | ________ | ________ | ________ | ________ |

*Complete for historical years only.

# Worksheet 1B: Total Campus Energy Indices (EUI)

Use the Energy Utilization Indices you calculated in Worksheet 1A, column 6 (historical).

Energy Utilization Index (EUI)
(From Worksheet 1A, Column 6)
(Historical)

| Year | Fuel 1 | + | Fuel 2 | + | Fuel 3 | = | EUI |
|---|---|---|---|---|---|---|---|
| ______ | ____________ | + | ____________ | + | ____________ | = | ____________ |
| ______ | ____________ | + | ____________ | + | ____________ | = | ____________ |
| ______ | ____________ | + | ____________ | + | ____________ | = | ____________ |
| ______ | ____________ | + | ____________ | + | ____________ | = | ____________ |
| ______ | ____________ | + | ____________ | + | ____________ | = | ____________ |

# Worksheet 1C: Total Campus Energy Indices

**Calculate the total energy cost per gross square foot using the figures from Worksheet 1A, column 7 (historical).**

Total Cost Per Gross Square Foot
(From Worksheet 1A, Column 7)
(Historical)

| Year | Fuel 1 | + | Fuel 2 | + | Fuel 3 | = | Total Cost Per Gross Sq. Ft. |
|---|---|---|---|---|---|---|---|
|  |  | + |  | + |  | = |  |
|  |  | + |  | + |  | = |  |
|  |  | + |  | + |  | = |  |
|  |  | + |  | + |  | = |  |
|  |  | + |  | + |  | = |  |

## Worksheet 2A: Weather-Adjusted EUI

| Year | 1. Heating Degree Days | + | 2. Cooling Degree Days | = | 3. Total Degree Days | 4. Actual EUI | 5. Weather-Adjusted EUI | 6. Guidelines EUIs from Fig. 2A |
|---|---|---|---|---|---|---|---|---|
| | | + | | = | | | | |
| | | + | | = | | | | |
| | | + | | = | | | | |
| | | + | | = | | | | |
| | | + | | = | | | | |
| **Normal**<br>(Long term)** | | + | | = | | | | |

*Calculation method for weather-adjusted EUI *(Check one)*

☐ Linear Regression
enter factors: A = __________, B = __________
$EUI = A + B \times X$

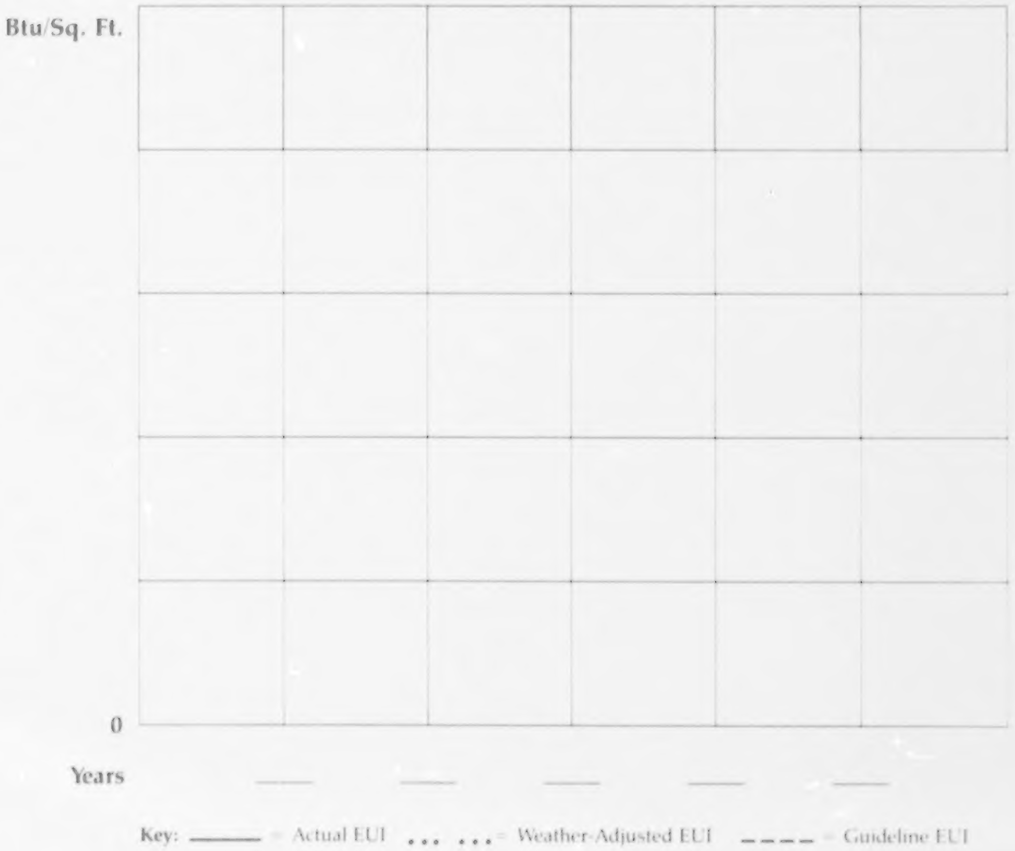
☐ Averaging per Degree-Day:
enter factor [Avg EUI/DD] = __________
$EUI = DD \times (\text{Avg } EUI/DD)$

**See Step 1, Exercise 3.

# Worksheet 2B: EUI/Guideline

**Vertical Axis Options**

1. Full scale 0-50; each line equals 10 KBtu
2. Full scale 0-100; each line equals 20 KBtu
3. Full scale 0-150; each line equals 30 KBtu
4. Full scale 0-200; each line equals 40 KBtu
5. Full scale 0-250; each line equals 50 KBtu
6. Full scale 0-______;



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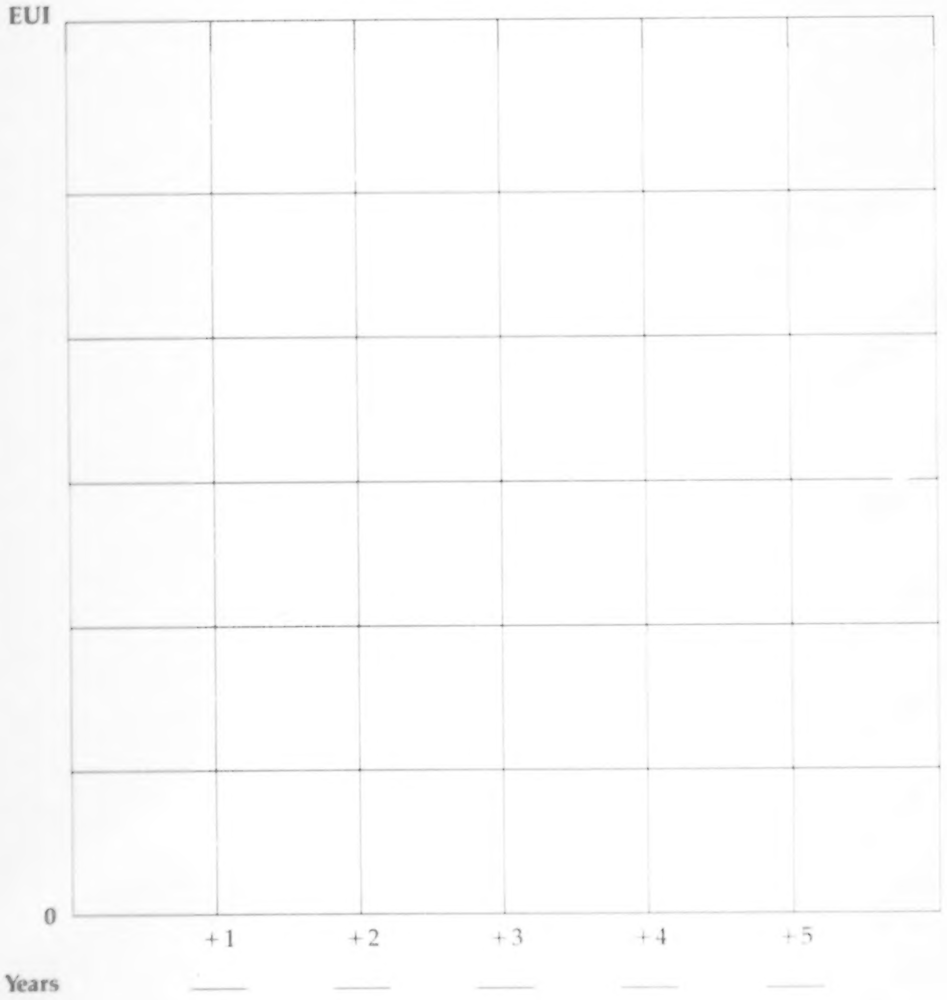
# Worksheet 3: Projected Future Energy Use



**Key:**

A = Capital Modification Line

B = Normal Guideline EUI

C = Normal Weather-Adjusted EUI

—·— = Projection with Energy Management Program

······· = Projection without Energy Management Program

▨ Non-Capital Modifications

▧ Capital Modifications

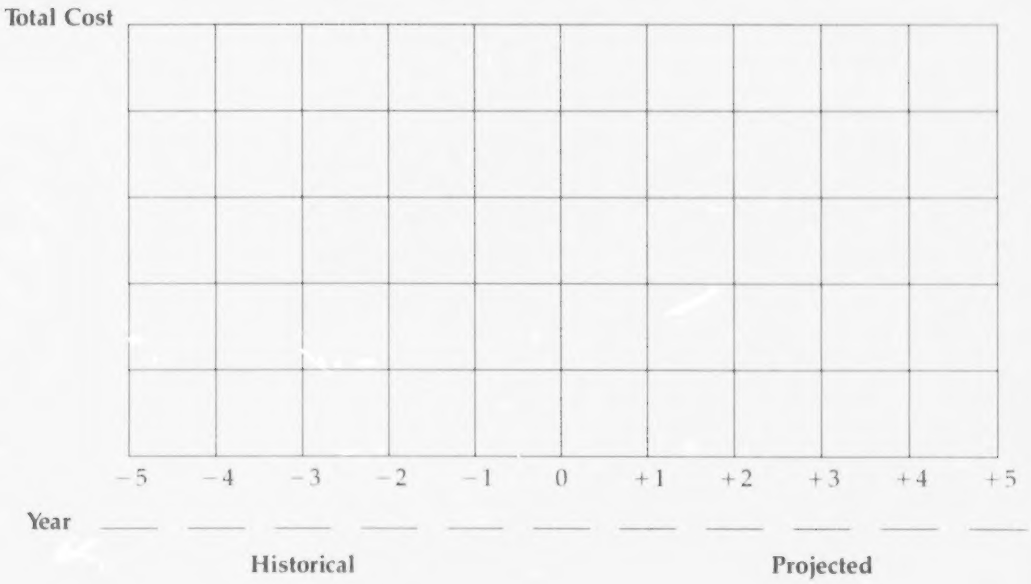
## Worksheet 4A: Cost Calculations

| Year | 1. Actual EUI | 2. Total Cost/ Sq. Ft. | 3. Btus per Dollar | 4. Inflation Factor | 5. Future Cost No Change | 6. Energy Management EUI | 7. Energy Management Costs |
|---|---|---|---|---|---|---|---|
| This year | ______ ÷ | ______ = | ______ | ______ | | | |
| ______ | ______ | ______ | ______ | ______ | ______ | ______ | ______ |
| ______ | ______ | ______ | ______ | ______ | ______ | ______ | ______ |
| ______ | ______ | ______ | ______ | ______ | ______ | ______ | ______ |
| ______ | ______ | ______ | ______ | ______ | ______ | ______ | ______ |
| ______ | ______ | ______ | ______ | ______ | ______ | ______ | ______ |

[1] Normal Weather-Adjusted EUI: __________

[1] Normal Weather-Adjusted EUI: (See Worksheet 2A)

## Worksheet 4B: Cost Calculations Chart



# Worksheet 5A: Condition Evaluation

Building name or campus number: ____________________

Types of assignable space:

☐ Classroom
☐ Laboratory
☐ Study
☐ Special
☐ General Use
☐ Supporting
☐ Healthcare
☐ Residential
☐ Office
☐ Unclassified

Notes: ____________________

____________________

Size: Assignable Square Feet: ________
Total Square Feet: ________
Divide Assignable Square Feet by Total Square Feet to obtain the ratio:
________ : ________

**Summary Grades:**

Functional Evaluation ______
General Condition ______
Capital Investment (Average) ______
Management Condition ______
Functional Condition Evaluation ______
General Condition ______

**Capital Investment Evaluation**

Passive systems:

Roof insulation ______
Wall insulation ______
Wall tightness ______
Window frames ______
Window glazing ______
Exterior door tightness ______

Active systems:

Boilers ______
Furnaces ______
Cooling: chillers ______
Cooling: window units thru-wall units ______
Heating/cooling distribution ______
Ventilation fans/dampers ______
Lighting ______
Domestic hot water ______
Special facilities (list) ______

Worksheet 5A: Condition Evaluation, (Continued)

**Total Capital Investment Grade Point** ________
Total number of grades ________
Average Capital Investment Grade ________

**Management Condition Evaluation:**
Efficiency of space scheduling ________

**Energy awareness of building staff and users:**
General awareness ________
Closing exterior doors, including vestibules ________
Appropriate use of windows ________
Proper control of lighting ________
**General maintenance of building systems:**
Heating plant, if in the building ________
Cooling plant, if in the building ________
Control systems for heating/cooling ________
Lighting (fixtures cleaned) ________

Space temperatures during occupied hours ________
Operating schedules and conditions of
major heating/cooling systems ________
Operation of building when vacated ________
Building energy manager (if any) ________

**Total Grade Points for Management:**
Number of grades included in the total: ________
Average Management Grade: ________

# Worksheet 5B: Building Grade Point Rankings

**BUILDINGS RANKED BY CAPITAL INVESTMENT**

| Grade Point | Building | Letter Grade |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

BUILDINGS RANKED BY MANAGEMENT CONDITION

| Grade Point | Building | Letter Grade |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Refer to pages 58-60 for worksheet instructions, steps 1-5.

# Worksheet 6: Noncapital Energy Savings Improvements

| Energy Management Measures to be Implemented | Building | Building | Building |
|---|---|---|---|
| Schedule Adjustments | | | |
| Operations | | | |
| Maintenance | | | |

# Worksheet 7: Components of an Energy Reduction Plan

A. Operations and maintenance (pages 25-28)

| Action | Estimate costs | Consumption/costs estimate BTU |
|---|---|---|
|  |  |  |

B. Buildings utilization and policy (page 77)

| Building/Action | Cost saving | O&M saving | Energy | Total savings |
|---|---|---|---|---|
|  |  |  |  |  |

C. Capital Actions (page 98-100)

| Actions | Buildings | Cost (1,2,3,4) | Cumulative cash flow improvement |
|---|---|---|---|
|  |  |  |  |

## Cashflow Improvement Chart

Prepare a chart for each energy efficiency investment measure to be implemented.

Measure:

| Year | Cost | Savings | Added O&M | Finance costs | Net savings | Cumulative |
|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

## Summary of Results

If the total (O&M, Building utilization, consolidation, and energy efficiency improvements) Energy Management Plan is implemented, your cash flow improvement over the next three years would include

| Year | Cost | Savings | Net improvement | Cumulative |
|---|---|---|---|---|
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

List other buildings and campus benefits that are directly impacted by the implementation of the energy efficency investments, such as more attractive campus, better climate control, equipment replaced.

# Worksheet 8: The Planning Matrix

| Project | Priority | Start Date | Completion Date | Responsibility | Anticipated Cash Flow 10 Years |
|---|---|---|---|---|---|
| | | | | | |

| Implementation Cost $000's | Financial Source | Facility, Academic & Management Implications | Expected EUI Savings |
|---|---|---|---|
| | | | |

| Project | Priority | Start Date | Completion Date | Responsibility | Anticipated Cash Flow 10 Years |
|---|---|---|---|---|---|
| | | | | | |

| Implementation Cost $000's | Financial Source | Facility, Academic & Management Implications | Expected EUI Savings |
|---|---|---|---|
| | | | |

| Project | Priority | Start Date | Completion Date | Responsibility | Anticipated Cash Flow 10 Years |
|---|---|---|---|---|---|
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| Implementation Cost $000's | Financial Source | Facility, Academic & Management Implications | Expected EUI Savings |
|---|---|---|---|
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# ■ Bibliography

**APPA: The Association of Higher Education Facilities Officers.** *CFC Strategies and Alternatives.* Alexandria, Virginia: APPA, 1993.

———. *Comparative Costs and Staffing Report for College and University Facilities.* Alexandria, Virginia: APPA, biennial.

———. *Facilities Renewal at the Small College.* Alexandria, Virginia: APPA, 1991.

———. *Operations & Maintenance.* (Critical Issues in Facilities Management series.) Alexandria, Virginia: APPA, 1992.

———. *Physical Plant Job Descriptions.* Alexandria, Virginia, 1991.

———. *Planning for Improved Campus Facilities.* Alexandria, Virginia, 1992.

**Association of Physical Plant Administrators of Universities and Colleges (APPA).** *Capital Renewal and Deferred Maintenance.* (Critical Issues in Facilities Management series.) Alexandria, Virginia: APPA, 1989.

———. *Energy Management.* (Critical Issues in Facilities Management series.) Alexandria, Virginia: APPA, 1990.

———. *Facilities Stewardship in the 1990s.* Alexandria, Virginia: APPA, 1991.

———. *Management Basics.* (Critical Issues in Facilities Management series.) Alexandria, Virginia: APPA, 1990.

———. *Planning, Design, and Construction.* (Critical Issues in Facilities Management series.) Alexandria, Virginia: APPA, 1990.

———. *Regulatory Compliance for Facilities Managers.* Alexandria, Virginia: APPA, 1989.

**Black, Paul D.** "Electrical Energy Management Through Lighting Retrofits." In *Proceedings of the 77th Annual Meeting of APPA.* Alexandria, Virginia: APPA, 1990.

**Bland, Robert R.** "The Cogeneration Project at Cornell University." *Facilities Manager*, Spring 1987.

**Bosco, Pearl.** "Energy Rebates: Bright Lights, Big Bargains." *Buildings*, February 1992.

**Burger, Robert.** "Cooling Tower: The Neglected Orphan." In *Proceedings of the 76th Annual Meeting of APPA.* Alexandria, Virginia: APPA, 1989.

**Carver, Glen L.** "Thermal Energy Storage for the Large and Small Campus." In *Proceedings of the 77th Annual Meeting of APPA.* Alexandria, Virginia: APPA, 1990.

**Chapman, Perry.** "The Campus Plan: A Process of Engagement and Momentum." In *Proceedings of the 74th Annual Meeting of APPA.* Alexandria, Virginia: APPA, 1987.

**Christenberry, George A. Jr.** "Georgia's Telephone Destiny." *Government Technology*, September/October 1988.

**Dillow, Rex O.**, ed. *Facilities Management: A Manual for Plant Administration*, second edition. Alexandria, Virginia: APPA, 1989.

**Dunn, John A. Jr.** *Financial Planning Guidelines for Facility Renewal and Adaption.* Ann Arbor, Michigan: Society for College and University Planning, 1989.

**Dwyer, Michael J. Jr.** "Free Cooling: How and Why." In *Proceedings of the 76th Annual Meeting of APPA.* Alexandria, Virginia: APPA, 1989.

**Energy Information Administration.** *Annual Energy Outlook 1989 with Projections to 2000.* Washington, D.C.: U.S. Department of Energy, 1989.

**Fackler, F. Louis.** "Alternate Financing of Campus Projects." In *Proceedings of the 71st Annual Meeting of APPA.* Alexandria, Virginia: APPA, 1984.

**Gellings, Clark W., and John H. Chamberlin.** *Demand-Side Management Planning.* Lilburn, Georgia: Fairmont Press, 1993.

**Government Institutes, Inc.** *Energy Technology XVI: Energy Progress and Environmental Protection.* (Proceedings of the 16th Energy Technology Conference.) Rockville, Maryland: Government Institutes, 1989.

**Haley, John E.** "Thermal Energy Storage: A State-of-the-Art Approach to an Ancient Technology." In *Proceedings of the 79th Annual Meeting of APPA.* Alexandria, Virginia: APPA, 1992.

**Hansen, Shirley J.** *Performance Contracting for Energy and Environmental Systems.* Lilburn, Georgia: Fairmont Press, 1993.

**Hay, Lelson E.,** ed. *Guide to Natural Gas Cogeneration.* Lilburn, Georgia: Fairmont Press, 1988.

**Health Resources Publishing.** *How 25 Hospitals are Saving Millions in Energy Use.* Wall Township, New Jersey: Health Resources Publishing, 1989.

**Hines, Jim.** "Home Made Energy Management System: A Do-It-Yourself Success Story." *Facilities Manager,* Fall 1988.

**Howard, Steve,** ed "Improving Management Through New Technologies." *Facilities Manager,* Summer 1986.

**Jackson, Marilyn,** compiler. *Power Generation, Energy Management & Environmental Sourcebook.* Lilburn, Georgia: Fairmont Press, 1992.

———. ed. and compl. *Innovative Energy & Environmental Applications.* Lilburn, Georgia: Fairmont Press, 1993

**Johnson, Robert C., and Diana M. Schmidt.** "The National Energy Policy Act of 1992: Implications for Meeting Our Energy Needs." *Facilities Manager,* Winter 1994.

**Kaiser, Harvey H.** *Crumbling Academe: Solving the Capital Renewal and Replacement Dilemma.* Washington, D.C.: Association of Governing Boards of Universities and Colleges, 1984.

———. *The Facilities Audit: A Process for Improving Facilities Conditions.* Alexandria, Virginia: 1993.

**Karkia, M. Reza.** "Energy Conservation Projects and Their Positive Impact on the Economy." *Facilities Manager,* Winter 1994.

**Layzell, Daniel T., and Jan W. Lyddon.** *Budgeting of HIgher Education at the State Level: Enigma, Paradox, and Ritual.* Washington, D.C.: ASHE/ERIC, 1990.

**Levine, Ruth N.** "Packaged Cogeneration Systems." In *Proceedings of the 74th Annual Meeting of APPA.* Alexandria, Virginia: APPA, 1987.

**Maxson, David M.** "Cost Savings with Electrical Centrifugal Chillers." *Facilities Manager,* Winter 1989.

**McCullough, Jim, and Pat Dennis.** *Academic Research Facilities: Financing Strategies. Report of a Conference.* Washington, D.C.: National Academy of Sciences, 1986.

**McFadden, Dick.** "New EMS at Holy Cross Users Computer-Activated Steam Valves." *APPA Newsletter,* December 1988.

**McNabb, Linda.** "Baylor University to Save with Cogeneration Unit." *APPA Newsletter*, November 1988.

**Meckler, Milton.** *Innovative Energy Design for the '90s.* Lilburn, Georgia: Fairmont Press, 1993.

**Morille, Rock D.** "One Institution's Approach to Energy Conservation." *Facilities Manager*, Spring 1993.

**Myers, James R.** "Evaluating Boiler Useful Life for Project Planning." In *Proceedings of the 76th Annual Meeting of APPA.* Alexandria, Virginia: APPA, 1989.

**National Association of Regulatory Utility Commissioners.** *The 1992 Directory of Energy Professionals.* Washington, D.C.: National Association of Regulatory Utility Commissioners, 1992.

**National Lighting Bureau.** *Profiting from Lighting Modernization.* Washington, D.C.: National Lighting Bureau, 1988.

**Novitski, B.J.** "Energy Design Software." *Architecture*, June 1993.

**Payne, F. William**, ed. *The Cogeneration Sourcebook.* Atlanta: Fairmont Press, 1985.

———. *Integration of Efficient Design Technologies.* Lilburn, Georgia: Fairmont Press, 1988.

———. *Strategic Planning and Energy Management Journal*, Winter 1989/1990.

———. *Strategic Planning for Energy and the Environment.* Lilburn, Georgia: Strategic Planning for Energy and the Envronment Journal, 1990.

**Pearce, Fred.** "How Economic Growth Can Be Greenhouse Friendly." *New Scientist*, July 8, 1989.

**Piper, James E.** "A Step-by-Step Plan for Achieving Lighting Energy Efficiency." *Builidng Operating Management*, May 1992.

**Qayoumi, Mohammad H.** "Demand Side Management." *Facilities Manager*, Fall 1992.

———. *Electrical Distribution & Maintenance.* Alexandria, Virginia: APPA, 1989.

**Ragusa, Sam.** "Designing for Energy Management: Award Winning Techniques." *Facilities Manager*, Winter 1991.

**"Renewable Energy Source Saves $ for Southeast Asia."** *Facilities Manager*, Winter 1993.

**Reinbach, Andrew.** "The Green Retrofit." *Buildings,* February 1993.

**Rush, Sean C., and Sandra L. Johnson.** *The Decaying American Campus: A Ticking Time Bomb.* Alexandria, Virginia: APPA, 1989.

**"Rutgers Plan Conserves Energy and Environment."** *Facilities Manager,* Fall 1993.

**Sadowski, John.** "Saving Energy Costs with a Natural Gas Marketer." *APPA Newsletter,* December 1993.

**Schiller, Steven R.** "Developing Cogeneration for University and College Campuses." In *Proceedings of the 73rd Annual Meeting of APPA.* Alexandria, Virginia: APPA, 1986.

**Schott, Glenn H., and Patrick E. Flanagan.** "Electrical Power Distribution System for a Small College Campus.," In *Proceedings of the 75th Annual Meeting of APPA.* Alexandria, Virginia: APPA, 1988.

**Schwed, Robert L.** "Just a Subtle Warning." *Engineered Systems,* May/June 1989.

**Sensbach, Werner K.** "Illuminating the University Campus: Aspects of Security, Aesthetics, and Efficiency." *Facilities Manager,* Spring 1990.

**Simpson, Walter.** "Recharging Campus Energy Conservation: ESCOs and Demand Side Management at SUNY Buffalo." *Facilities Manager,* Winter 1994.

**Spiewak, Scott A.** *Cogeneration and Small Power Production Manual.* Lilburn, Georgia: Fairmont Press, 1987.

**Sraeel, Holly.** "The Quest for Energy-Efficient Buildings." *Buildings,* February 1992.

**Studebaker, John M.** *Slashing Utility Costs Handbook.* Lilburn, Georgia: Fairmont Press, 1993.

**Tatum, Rita.** "Financing Energy-Saving Retrofits." *Building Operating Management,* March 1992.

**Thumann, Albert.** *Introduction to Efficient Electrical Systems Design,* second edition. Lilburn, Georgia: Fairmont Press, 1991.

**Turner, Wyane C.** *Energy Management Handbook,* second edition. Lilburn, Georgia: Fairmont Press, 1993.

**"Universities Win Cogen Grants."** *Facilities Manager,* Summer 1992.

**Wargo, James A.** "Mod Five: Planning, Promoting, and Building a Central Chiller Plant." *Facilities Manager*, Fall 1991.

**Weeks, Warren M.** "Improving District Cooling System Performance." *Facilities Manager*, Winter 1994.

**Williams, Anna Fay,** ed. *Software Applications and Directory for Energy Analysis.* Lilburn, Georgia: Fairmont Press, 1992.

**Zanis, Larry.** "10 Things Building Owners Should Know About Energy-Efficeint Retrofits." *Building Operating Management*, January 1993.

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